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This is a monthly publication presenting brief articles concerning recent developments in European Scientific Research. It is hoped that these articles (which do not constitute part of the scientific literature) may prove of value to American scientists by disclosing interesting information well in advance of the usual scientific publications.

The articles are written primarily by members of the staff of ONRL, with certain articles prepared by, or in cooperation with, members of the scientific staffs of the European Research Office. Articles are also

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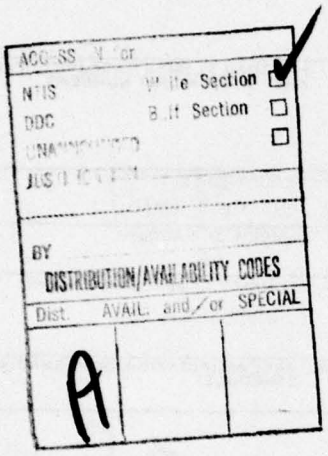

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ESN readers/subscribers are requested to note the new order form for ONRL Reports. The present format is now printed inside of the address cover, instead of on several end pages as was done formerly. This new method of printing and distribution of order forms also allows the further economy of combining the ONRL Report request form with change of address and cancellation requests. (J.E. Cook)

BEHAVIORAL SCIENCES

PILOTS, DIVERS AND BEETLES AT THE INSTITUTE OF AVIATION MEDICINE

The Institute of Aviation Medicine was established in 1952 in Bonn-Bad Godesberg as one of 25 to 30 laboratories comprising the German Research Institute for Aviation and Spaceflight (DFVLR). This parent organization is an outgrowth of an earlier institute first organized in 1912 by the aircraft industry to serve as a sort of private Bureau of Standards-type test facility. After a hiatus following WWII, DFVLR was re-established in the early 1950's and now falls under the cognizance of the Ministry of Science and Technology, employing about 3,000 to 3,500 persons.

The Institute of Aviation Medicine (Kolner Strasse 70, 5300 Bonn-Bad Godesberg) employs about 60 persons of which 25 are scientists representing such areas as psychology, biology, medicine, physics, chemistry and engineering. Dr. Karl-Egon Klein, who became the Director of the Institute in 1974, explained that the Institute also has a laboratory located at the German Air Force Base at Furstenfeldbruck, near Munich. The Institute has six branches: Underwater Medicine, Aviation Physiology, Aviation Psychology, Biodynamics, Space Biology, and Biochemistry. There also are several special project groups.

The facilities, although located in a collection of small buildings and houses, are quite impressive. They include: a human centrifuge (built in 1957) with several interchangeable gondolas equipped with real-time readouts for biomedical data, well-equipped biochemical laboratories, a hyperbaric chamber with sophisticated equipment for measuring biomedical parameters, biological laboratories and excellent support facilities including a large well-equipped machine shop. In addition the Institute owns and operates four light aircraft.

The writer had an opportunity to discuss on-going research with members of the staff in areas of selection and training, human performance, physiology, and biology.

In the area of selection and training there are several projects underway. The one with the longest history is a 21-year old contract with Lufthanza, currently under the direction of Dr. Klaus-Martin Goeters, which involves the selection of airline pilots. A battery of selection tests and procedures has been developed over the years which has a 90-95% success rate, i.e., almost all of those selected for pilot training satisfactorily complete the program and become qualified pilots. Goeters, a psychologist located at a branch office in Hamburg, also is involved in a diver selection program. Along these lines he completed a study recently of the visual-motor orientation of divers in water with varying degrees of turbidity. In earlier studies (1973-74) Goeters studied personality characteristics of 14 divers living in a German Underwater Laboratory at Helgoland. These studies included measures of reasoning, short-term memory, and manual dexterity as well as a personality profile. He found in each case that performance under pressure was poorer than on the surface. It also was found that divers characteristically are physically oriented, more introverted, less orderly and more aggressive than non-divers. Using these data as a base, this study will continue in the future under a sub-contract to the Draegerwerks Co. of Lubeck, FRG, but will be aimed at commercial divers. A similar program is underway in the UK ESN (30-5:205).

Dr. Heinz Oser, the acting head of the selection and training programs, currently is involved with the selection of payload specialists (astronaut scientists) for the forthcoming Spacelab program to take place in 1980 in conjunction with NASA. This effort is in cooperation with the European Space Agency. On behalf of this same agency, a similar program is underway in the UK under the cognizance of the RAF in which selection criteria for payload specialists are being developed under the supervision of Dr. Patrick O'Connell (Kelvin House, Cleveland St., London W1P 6AV).

There are several studies underway at the Institute relating to human physiology and performance. One such study is concerned with determining the effects of vibration on animals suffering from various types of injuries. The study, which is supported by the Porsche Automobile Co., involves placing the animals on the centrifuge and vibrating them at different frequencies during acceleration. The

results of the study will be used by Porsche in the design of ambulances in an effort to reduce the incidence of complications to existing injuries while the patient is being transported.

A human performance study also is being carried out to assess the capabilities of pilots to perform under different stress levels and workloads. Coupled with this program is a continuing study of the effects of time shifts, jet lag, etc., on performance of both pilots and non-pilots before, during and following long inter-time-zone flights.

During March 1976 a group of 15 scientists and engineers from the Institute of Aviation Medicine flew to Washington, D.C. for a meeting. For several weeks before and after this trip all the members of this group were used as subjects for a time-shift study (an excellent cost-effective approach). Specimens of urine and blood were obtained regularly, a variety of biochemical assessments made, as well as subjective performance assessments, to determine whether there were changes caused by the trip.

Investigations involving hyperbaric physiology are being conducted primarily under the direction of Dr. H. D. Fust. The purpose of these studies is to measure the effects of rapid compression from one depth to another, e.g., 30 to 70m, 70 to 130m, and 130 to 200m, each of which is accomplished in one minute. Fust is particularly interested in signs of the high-pressure nervous-syndrome (HPNS) as indicated by finger tremor (a commonly used measure). Fust reports that the results, to date, reveal some slight tremor, but are not interpreted as indicative of significant HPNS symptoms. To extend this work further, a saturation dive at a depth of 230m is planned for the next year.

Other hyperbaric physiological work, under the direction of Oser, concerns the development of faster decompression tables from dives in the range of 120 to 150m. Of particular interest is the effect of large pressure reductions in the beginning of a decompression schedule followed by liberal use of oxygen in the middle which is followed in turn by rapid decompression near the surface. A list of the 74 hyperbaric physiology publications of the Institute of Aviation Medicine spanning 15 years can be obtained by writing to Oser.

An interesting space biology program is being conducted under the direction of Dr. Wolfgang Briegleb. The experiments are concerned with the effects of reduced gravity on the genetic characteristics of plants and animals such as frogs, tadpoles, beetles and the water plant *Elodea spec.* The apparatus used to simulate weightlessness is a fast-rotating (up to 100 rpm) clinostat equipped with a high-power microscope. In a viscous liquid which rotates rather fast about a horizontal axis, heavy particles near the center of rotation are forced to behave as if they were weightless. This is because the time available for establishing a uni-directional status approaches zero, thus sedimentation is not possible as would be the case under normal gravity conditions. The writer had the opportunity to see this device in action and to watch photomicrographic movies taken during actual rotating experiments involving both plants and animals. It was fascinating indeed to see individual plant cells floating in a weightless state and to compare this condition with cell behavior under normal circumstances. When viewing a movie of the Canadian watercress plant being rotated at 100 rpm, it was possible to see Brownian movement of uniformly distributed cells.

Experiments also have been conducted with live flour beetles, *Tribolium Confusum*, in which they were rotated continuously for periods ranging from a few days up to 9 to 10 weeks. It has been found that the incidence of mutation in these beetles in the generation immediately following the one rotated is significantly increased, as shown for example, by deformed wing and leg structure. Although the sample is small, it has been observed further that this mutation is transmitted to the following generation even when breeding is done later under normal gravity conditions. These little beetles (4mm long) have a life span of six weeks. Thus, Briegleb has been able to rotate them continuously for over a generation and a half. Additional experiments are now being conducted with the rice beetle to further verify these results. Publications describing this work can be obtained from Briegleb. Although flour beetles are a long way, phylogenetically speaking, from man, these preliminary results do raise some interesting questions about the effects on man of long-term exposure to reduced gravity or weightlessness. (J. W. Miller)

THE HUMAN - A CONTROLLER, MONITOR OR SUPERVISOR?

During the week of 8-12 March 1976 Berchtesgaden, Germany, was the site of a symposium entitled "Monitoring Behavior and Supervisory Control." The principal purpose of the meeting was to discuss and analyze the changing role of the human operator in today's world of rapidly advancing technology. The Symposium was sponsored by the NATO Scientific Affairs Division (Human Factors) and was directed by Prof. Thomas B. Sheridan, Dept of Mechanical Engineering, Massachusetts Institute of Technology, and Dr. Gunnar Johannsen, Research Institute for Human Engineering, Meckenheim, FRG. The meeting, which was attended by approximately 110 persons from 15 countries, was conducted entirely in English, was well organized and was held in a modern conference center in Berchtesgaden. Preprints of all talks were distributed at the meeting, which helped in overcoming language difficulties. This article will only summarize the meeting, as a more detailed conference report is in preparation by the writer.

The Symposium was divided into three major sessions: Man-Vehicle Control, General Models, and Process Control, each of which began with a 30-minute overview. The Man-Vehicle control session was opened by Johannsen, who did an excellent job of putting the papers which followed into a general context relating to the changing role of the human from operator to controller to monitor to supervisor. He pointed out that many of the basic tasks of the human operator have changed from sensorimotor (physical skills) to mental skills and that the so-called unburdening of the human operator by automatic systems perhaps more rightly should be referred to as a shift in task emphasis.

Johannsen's presentation was followed by a series of 13 papers describing various types of systems and the role of the human in each. Technical areas discussed included military and commercial aircraft systems, automobile driving, air traffic control and general display systems. A paper by Dr. J. Smit (National Aerospace Laboratory, The Netherlands) is illustrative of one approach to measuring human performance in the field. His talk, entitled "Pilot Workload Analysis Based Upon In-flight Physiological Measurements and Task Analysis Methods", described an effort to measure pilot performance during standardized low-level ground-attack missions. During approximately 20 flights by ten pilots objective flight performance data, physiological data, and subjective impressions of the pilot were obtained. The flight performance and physiological data were recorded in digital form for subsequent computer analysis. This was a feasibility study and the data are still being analyzed to determine whether this is a valid method of assessing pilot performance.

The effect of the change in the human role from operator to supervisor on selection and training procedures, and the anticipated reluctance on the part of existing organizations to make such changes because of vested interests, were discussed at some length. An interesting point made along these lines was that it is now becoming less expensive to change hardware than to change software. This is due to many reasons, such as the increasing use of the modular approach in equipment design and the increasing costs of programmers and related specialists.

The General Models Session was opened by Sheridan, who reminded the audience that mathematical modelers have been challenged in the past for their audacity to suggest that human behavior can be reduced to mathematical equations. He said the usual reply is that man-machine interactions are utilitarian and mechanistic and therefore amenable to mathematical prediction. Sheridan pointed out, however, that because the computer is now gradually taking over the routine, predictable and definable tasks, leavin the more complex actions to the man, existing generalizations about modeling of human behavior may no longer be valid. Another rather interesting question raised which needs to be considered when developing models of human behavior, was, "When should the machine be given the power to decide what information to display to the man or what controls to allocate to him?"

Sheridan's talk was followed by 11 papers relating to mathematical modeling of human behavior. These talks covered such topics as visual detection the human as an adaptive controller, the human as a failure detector, and queueing theory as applied to supervisory control. A number of models were described including a system involving a digital computer

program capable of simulating the performance of a goal-oriented adaptive, trained human operator in a complex weapon system (R.J. Wherry, Jr., US Naval Air Development Center, Warminster, PA). This system can be used in human engineering crew procedures, crew station design and test and evaluation efforts.

The term "internal model" was used liberally during several presentations and in much of the discussion. This concept, which dates back to 1943, is that the human observer has in his head a model of the world about him consisting of relevant background information pertaining to a task to which he is giving attention. The model -- which includes the observer's value structure, a weighting system, an updating capability and an overall statistical representation of time and space -- determines the manner in which the individual responds to events occurring in the external world. The availability of powerful on-line computers has rejuvenated the internal model concept. Unfortunately, at least in the writer's opinion, this rejuvenation has also resulted in a maze of new jargon drawn from control and signal detection theory, mathematics, engineering and biotechnology which creates an aura of pseudosophistication and validity in an area which is still very heavily speculative.

The Process Control Session was introduced by Dr. Elwyn Edwards of the University of Technology, Loughborough, UK. He placed control systems into four categories: Software, Hardware, Environment, and Liveware. The concept of a system described in terms of these four component types and emphasizing their interactions has been called the SHEL model. Edwards feels that such a model can provide a framework for revealing and structuring the problems associated with highly interactive man-machine systems. His point is that a piece-by-piece analysis of operators' tasks will provide only part of the answers needed for systems development. It is necessary to put the individual tasks into a broader context, such as the SHEL model, where operator strategy and general performance can be assessed more adequately.

A series of 12 papers followed which described a number of practical situations, primarily in industrial settings, in which operator tasks were analyzed both experimentally and by observing on-the-job performance in emergencies in a nuclear power plant, man-robot interfaces on assembly lines, performance in aircraft display and control systems, and laboratory experiments in which various man-computer interface relationships were investigated.

Towards the end of the meeting the participants were divided randomly into four working groups for two, one-half day periods. The mandate for these groups was "What do we tell our governments and colleagues about research priorities, implementation of results, integration of various disciplines, and institutional arrangements?", with respect to the development of complex man-machine systems. Although the group discussions were informal, each group leader was tasked to summarize the opinions of the group and to make specific recommendations as to what lines of research should be undertaken relating to the questions raised and priorities established. While no single conclusion or edict was reached during the workshop discussions, there were a few points on which there seemed to be agreement, namely: further work was needed to demonstrate the utility of models of human behavior; selection and training criteria may need to be revised because of the changing nature of the operator's role; and improved methods of assessing the operator's workload must be developed. The detailed results and recommendations of these workshops will be included in the proceedings of the Symposium.

The Symposium was valuable in that it afforded an opportunity to exchange ideas on the changing role of human endeavor in response to advancing technology. While there were many excellent papers, the writer was disappointed in the poor quality of some. This was reflected in part by a rehash of old stuff, but perhaps a more serious problem was the evidence of poor experimental design and/or data analysis.

Concern was expressed by many of the participants about the effect of the change of the human role on job satisfaction and the ability of workers to maintain skills which are called into use only in emergencies. This "simplification" of work also may be degrading in the eyes of the average worker and may in fact be viewed as a reduction in the quality of life. Sheridan stated the case well at the end of his presentation.

"As supervisory control becomes more commonplace, certain undignifying human tasks will be replaced by computer operation and supervisory

operators may delight in their new power. On the other hand, the operators may suffer from isolation and remoteness from the actual work. They may find their skills degraded when called upon to take over in emergencies. While they marvel at - or become alienated by - their powerful computer-slaves, they may abandon to the computer responsibilities which they as people should retain. And they may become even more confused between mechanical productivity and human fulfillment." (J.W. Miller)

THE 12TH INTERNATIONAL SYMPOSIUM ON APPLIED MILITARY PSYCHOLOGY

This series of annual conferences is designed to encourage the exchange of information among military psychologists about their programs, plans and problems. Although ONRL is a co-sponsor, each year a different country acts as host. This year the host country was France and the organization of the meeting was in the capable hands of Dr. Jacques Brémond, Medecin-en-Chef, Center for Research in Aviation Psychology (CERPAIR) Saint-cyr-l'ecole, France.

The theme of the symposium (which took place in Paris during 5-9 April) was to assess and analyze the contributions made by the psychological sciences to military organizations. Each attendee was requested to bring examples of programs which were initiated and/or developed by psychological or allied scientists for implementation into military systems. Throughout the meeting, an effort was made to determine the reasons for success or failure of the programs discussed. Criteria for determining whether a program was successful included: did the program result in faster mobilization, reduced training or maintenance time, reduced accidents or cost, etc. Reasons for failure included: failure to understand the problem, change in requirements, poor equipment or implementation, or simply bad timing and/or a change of commanding officers.

On the first day, following the usual introductions, Dr. Frederick W. Steege, (Ministry of Defense, FRG) presented an excellent survey of Personnel Psychology in the Federal Armed Forces (FAF) of Germany. There are about 130 psychologists in the FAF assigned to one of five branches of psychology, i.e., personnel, aviation, clinical, social and ergonomics. While Steege distributed a report containing an organization chart and a description of each of these five branches, he limited his discussion to the activities of the Personnel Psychology Branch. This branch is concerned with the selection and training of officers, volunteers, and conscripts, as well as the psychological assessment of civil servants. Steege described the methodology and tests used in each of these areas. Details of these programs will be included in an ONRL Conference Report now in preparation by the writer.

Of particular interest to the group was his description of a new procedure for the selection and training of officers. As part of this program, new military universities have recently been established in Munich and Hamburg (see ESN 30-4:157). Under the new system officer candidates receive 15 months of military training immediately after selection. Upon successful completion of this training, they are assigned to one of the two military universities for three years. They attend the university for 11 months a year and can specialize in such subjects as computer sciences, law, leadership, engineering, pedagogy or economics. Even though they are military institutions the instructors are all civilians. This program which began in 1974 now has 1200 students enrolled who were selected from about 14,000 applicants. The first class will graduate in 1976 and each graduate will receive a degree comparable to those awarded at civilian universities.

This formation of new military universities in Germany stimulated considerable discussion. Several attendees asked why existing civilian universities were not used for officer academic training. Steege explained that it was an effort to raise the standards of the officer corps and was partially in response to the anti-military riots in the civilian universities in the 1960's and early 1970's. By comparison, in France where civilians go to military schools and vice versa there have been no disciplinary problems except in the Army academy.

Following Steege's presentation, a talk was given by Major Ivan N. Evonic, acting Commanding Officer of the Canadian Forces Personnel Applied Research Unit, Toronto. His topic was Recruiting and Retention in the Canadian Forces. Evonic emphasized

that the manpower strength of the Canadian Forces is dwindling. Although increased recruiting efforts are being put forth they are not yet effective. Evonic feels this failure is due to the fact that they are not appealing to the right youths with the right pitch. He was lamenting the fact that no real effort has been made to assess properly the social and demographic characteristics of the potential volunteer pool. Recruiting techniques and the story line must change to attract the interests of today's youths. Sociological surveys are being developed in Canada to provide a basis for improved recruiting methods.

A personnel problem common to many countries represented is that information gathering is being viewed more and more as an invasion of privacy. Most attendees said that there were now severe restrictions on the use of questionnaires and psychological tests in general, and on the use of the results of such tests in particular. In Canada, for example, efforts to obtain information relating to personal matters must be part of a research program and such information cannot be obtained on an individual basis. In Denmark, which has a freedom-of-information law, there are severe restrictions on the methods of obtaining information. Once obtained, however, the individual concerned has access to all the information pertaining to him or herself. This is quite similar in many respects to the situation in the US. In Germany, officers holding the rank of General, must approve all questionnaires and the computer-storage of personal data. In France there are severe restrictions on the use of any kind of opinion surveys. A number of countries e.g., the US, Denmark, and Canada, attempt to minimize this problem by obtaining general personnel information through "buying space" in larger surveys.

Presentations also were made by Dr. J.W. Van Neden and Dr. F.J.B. Teerink, chief psychologists of the Royal Netherlands Army and Air Force, respectively. One of the most interesting aspects of their talks was the description of how unions operate within the Dutch armed forces. These unions, which have existed since 1925, should really be regarded as pressure groups reflecting the social climate, the law, and the press. For example, they do not have the legal right to strike and are mainly concerned with salary and living conditions. According to Teerink and Van Neden the existence of unions has not compromised the effectiveness of the Dutch Armed Forces. There does not seem to be a problem in switching from a permissive atmosphere in the barracks to a disciplinary one in the field. Thus, the behavior problems which do exist, are found in the barracks and other off-duty locations. An interesting aspect of the Dutch system is that members of the armed forces work a regular 40-hour week, receive overtime pay (including officers up to the rank of captain), and are payed at least at the minimum wage level.

By contrast, in France, according to Brémond, neither the politicians, officers nor enlisted men are in favor of unions within the armed forces, although the various political parties tacitly approve informal associations when and if they spring up. Along these same lines Brémond believes that resistance to social change by the armed forces will cause problems in the future. In France, youths of military age do not seem to be basically opposed to military service but do rebel against make-work activities. The anticipated reduction of the conscription period in France from one year to six months may well ease the objections of many young people now opposed to serving in the military. In general, according to the symposium attendees, military effectiveness does not seem to have been reduced by improved service conditions achieved by the various armed forces associations. This is of particular interest to the US where the role of unions in the armed forces is now being considered.

In keeping with the theme of the Symposium, several participants presented examples of programs initiated and implemented by psychological scientists. Dr. Ole Sucksdorff (Danish Institute of Military Psychology) described a program developed by his organization referred to as the Organizational Survey Feedback System. This system, which was instituted in 1972, has been extremely well received throughout the Danish Armed Forces. Once a year all personnel in operational, technical, and school units answer a questionnaire indicating their views on topics such as management and control, relations to immediate superiors, relations to peers, the job, and training effectiveness. The results are analyzed and tabulated so as to permit comparisons with results obtained by other units and with one's own

results from previous surveys. The anonymity of the individual respondents and their commanding officers is preserved at all levels. The company commander can evaluate the effectiveness of his own company relative to the average of all such companies, but he cannot compare it to any other individual company.

By contrast Brémond described an extensive, yet unsuccessful effort in the French Air Force involving programmed learning. A course was developed, successfully validated, and partially implemented, only to be cancelled completely due to a change of command which resulted in a return to the old way of teaching the same material. Other examples of problems involving program implementation were discussed which will be described in the Conference Report.

Extensive discussions were held relating to the causes of successful and unsuccessful programs and how programs in the future might be implemented more effectively. The very nature of psychological programs, e.g., selection, training, morale, etc., is such that they elicit strong feelings on the part of management and senior officers. The resulting decisions therefore made may not be based on objective data. Dr. Marshall Farr, Director of Personnel and Training Branch, ONR, listed 14 factors favoring the implementation of personnel and training programs. While many factors are involved, the single most important element for assuring successful program implementation is, in the collective opinion of the attendees, to obtain top-level, highly visible support at the initial development stage. While this is an obvious advantage for any program, it seems particularly important for programs relating to the psychological sciences.

Other topics presented and discussed included the role of conscientious objectors, leadership training, computer-aided instruction, programmed learning, air-crew selection, and bilingualism in the armed forces. In many cases written material was submitted which will be included in the Conference Report.

In general, the Symposium was both interesting and productive. The discussion, for the most part, was lively and yet informal. The reception provided by our French hosts and arranged for by Col. Brémond was delightful and set a standard that will be hard to follow. At the close of the meeting the Canadian representatives announced that Canada will be pleased to host the next meeting at the Canadian Forces Base, Lahr, West Germany, probably in April 1977. (J.W. Miller)

BIOLOGICAL SCIENCES

CELL SURFACE MARKERS--WHERE THE MEMBRANE MEETS THE ROAD

The seventh workshop on leukocyte cultures was held in Ulm, Germany 1-3 April 1976. The meeting took place at the new University, a huge complex of concrete buildings, which, except for the glass and 15-foot numbers on each building, would lead one to suspect that the pyramids were being rebuilt. Although the cold concrete failed (aesthetically), the friendly people soon warmed our spirits. The auditoriums and lecture rooms were exquisitely equipped, right down to the hand-held slide viewer to insure proper orientation for placing slides in the projectors. The school currently enrolls about 1,200 students in biology, physics, or chemistry, with two-thirds of them being in medical courses. The meeting was well organized, and was designed to bring investigators up-to-date on studies relating to the human mononuclear cells derived primarily from blood.

Following an introduction by Dr. H. D. Flad (University of ULM), the organizer of the meeting, T. B. Natvig (Institute of Immunology and Rheumatology, University Hospital, Oslo, Norway), reviewed the current status of surface markers on mononuclear cells, presenting a method of classifying cell types by their surface characteristics. Cell surface markers are those molecules or binding sites (receptors) located on the cell surface membrane that can be easily assayed and serve to identify certain populations of cells. There are two types of surface markers. First are the various proteins, lipids, and carbohydrates found on the surface membrane of the cell. The most well studied example in this group is the protein known as immunoglobulin, which is present on the surface of a portion of human cells. The second group of markers actually consists of receptors or binding sites for various substances. Human cells bind such things as sheep

red blood cells, Epstein Barr virus and measles virus. An important blood protein known as complement also binds, as does one end of a free immunoglobulin molecule known as the Fc end. Using these markers, cells can be immunologically characterized and classified into distinct populations. Mononuclear cells, which almost always come from human peripheral blood, can be divided into three subpopulations: the lymphocytes, the monocytes (circulating macrophages), and the remaining cells termed "null cells."

Lymphocytes, which have received the most attention because of the immune functions they perform, can be subdivided into T cells and B cells.

T cells originate from the thymus and have surface receptors for sheep red-blood cells and measles virus. T cells are responsible for graft rejection, and immunity to both fungal and viral infections. They make up about 60-70% of circulating lymphocytes. B cells, on the other hand, are responsible for immunoglobulin production and make up about 20% of circulating lymphocytes. They are identified by their surface immunoglobulin and receptors for complement, Epstein Barr virus, and the Fc portion of the immunoglobulin molecule.

Monocytes also carry complement and Fc receptors as do a portion of the null cells. One subpopulation of the null cells, thought by some to be related to the monocytes, are called killer cells or K cells, as they are capable of killing antibody-coated target cells.

Using Natvig's type of classification based on membrane markers, one can look at the blood mononuclear cells of patients with various disorders and determine if one population of cells is altered, giving a hint at the possible pathogenesis of the disease.

A number of papers dealt with this sort of study. For example, nearly all of the malignant cells circulating in patients with chronic lymphocytic leukemia bear B-cell markers, whereas in other types of leukemia, the cells may have both B- and T-cell markers or none at all.

Dr. Mel Greaves (University of London) presented an alternative approach looking at specific cell surface-antigens rather than receptors. He has been able to produce a rabbit antiserum specific for the surface-antigens on malignant cells of patients with acute lymphoblastic leukemia. Using this antiserum to identify a "tumor-specific antigen", he can now classify a small number of leukemias. Of special benefit is the ability to scan 10,000 cells/minute for the presence of this surface marker using a fluorescence-activated cell-sorter (FACS). When compared to the standard methods of visually scanning each cell under a microscope to determine its malignant potential, this technique enables one to scan large numbers of cells very quickly. The FACS method not only improves the ability to diagnose certain forms of leukemia but also enhances follow-up care for patients receiving therapy. The early detection of circulating malignant cells in the blood is important, as it indicates an impending relapse from therapy and the need for additional treatment.

In terms of the functional significance of these membrane receptors and other antigens these studies only scratch the surface. It is known that certain surface molecules and receptors bind antigens (substances that evoke an antibody response); cell surface immunoglobulin belongs to this category. Exactly what function such things as receptors for sheep red blood cells and viruses perform is not clear, nor is the role of complement or Fc receptors known, except that they may play a role in fighting certain bacterial infections.

When a skin graft is received from an immunologically foreign donor the host cells recognize certain glycoproteins, known as histocompatability antigens, on the surface of the graft tissue cells. The host cells mount a reaction against these foreign cells by producing killer T-cells that are capable of killing any cells having this foreign type of histocompatability antigen on their surface. Except in the case of transplants, the host cells are never exposed to a foreign type of histocompatability antigen. The question arises as to what these antigens actually do on the cell surface, since they are present on virtually every cell in the body. A possible role for these glycoproteins was described by Herman Wagner's group, (Mainz, Germany). They presented work showing that if the normal histocompatability antigens on the cell surface were modified by exposing the cell surface to trinitrophenol (TNP), the normal cells would now treat the TNP modified cells as being foreign,

and would form killer cells directed at the TNP cells as if they had foreign histocompatability antigens. This suggests that modification of the normal surface histocompatability antigens allows one to develop killer cells directed toward one's own modified cells but not against normal cells, more or less an auto-immune reaction.

The same phenomenon has been shown to operate in a number of mouse viral infections. When a cell is infected with virus, the viral proteins appear on the cell surface modifying the surface histocompatability antigens in the same manner as does TNP. The normal host cells recognize these altered histocompatability antigens as being foreign and produce killer cells capable of killing the virus infected cells. These studies give us a clue as to what goes on when one develops a viral infection, and how the body deals with it.

The suggestion was made that similar systems operate in humans, as the mononuclear cells also carry histocompatibility antigens (HLA antigens in the human). This ties in with reports from the University of Maryland (*New Scientist* 8 April 1976) where early diabetics were shown to have killer cells against insulin-producing pancreatic islet cells. The hypothesis is that certain viruses specifically infect the insulin-producing pancreatic cells. These virus-infected cells now have altered histocompatability antigens on their surface due to the new viral proteins. The other cells in the body (mainly T cells) recognize these virus-infected cells as being foreign and become killer cells that attack and destroy the virus-infected pancreatic cells. Usually this would cause no great changes in the body except in this case, the virus-infected cells also are responsible for insulin secretion, and once destroyed the diabetic condition develops. If this turns out to be correct, one might try to prevent infections with the specific strain of virus using vaccines or to block the generation of these killer cells after infection has occurred. In either case the hypothesis is most exciting but as yet unproven.

It may well be that many of the cell surface antigens are present as identification marks. Once altered, however, they subject the cell to recognition and destruction by the immune surveillance system--much as the leper was once cast out. (*J. N. Woody*, University College, London)

DRUGS IN FERMENT: A MOLECULAR SYMPOSIUM

The Biological Council (UK) has a Coordinating Committee for Symposia on Drug Action. Nothing could be more explicit, and the evidence printed on this year's program and on the 1970 program in front of me suggests that the Coordinating Committee coordinates several things: the choice of topic within the field of drug action, the appointment of a Symposium Committee, the sponsorship of some 14 scientific societies, and the financial support received from a wide circle of industrial concerns. I mentioned the 1970 program because on 13 and 14 April 1970 I attended a symposium entitled "Mechanisms of Toxicity" at the Middlesex Hospital Medical School while on 12 and 13 April six years later, in the same building, I listened to talks on "Drug Action at the Molecular Level." Although the two occasions were surprisingly similar, I thought that a comparison might show how the wind is blowing in the conduct of scientific meetings and in research on drugs.

The 1970 speakers were notably international; they hailed variously from Rijswijk, New York, Denver, Zagreb, Montreal, Bologna, Pittsburgh and Berlin. It was surprising, therefore, this year to hear Sir Arnold Burgen, the first chairman, make a point of the increasing international character of the symposia, for the percentage of foreign guests was actually a bit lower than in 1970. But he was really referring to the sponsorship, not to the participants: this year the International Union of Pharmacology and the International Union of Pure and Applied Chemistry were represented, and in 1977 the symposium will be organized right from the start by the Unions and will be held in Holland.

It may be idle to pursue the comparison of the two meetings to the bitter end. The earlier one dealt with toxicity and was necessarily broader in scope than the one on drug action, for all drugs are toxic if useful; many other substances are also toxic, but being useless are not dignified by promotion to drug status. So whereas the recent meeting dealt almost exclusively with normal enzyme function and the effects of specific inhibitors -- taking advantage of recent progress in molecular biology -- the earlier discussions of toxicity went beyond enzymes to gross chemical effects of poisons on proteins (e.g., acetylation

by aspirin), then to immune responses to toxic metals, and on to cellular injury sometimes leading to cell suicide and cell death. A session of that earlier meeting was devoted to the phenomenon called "lethal synthesis" by Sir Rudolph Peters, who in 1953 discovered the mechanism by which the non-toxic compound sodium fluoracetate leads to toxic accumulations of citrate in mitochondria. Examples of lethal -- or potentially lethal -- synthesis are found in the processing of man-made substances by the liver; enzymes that may detoxify one substance and prepare it for renal excretion may also convert harmless molecules into poisonous ones. This year V. Ullrich (University of Saarland) discussed the role of cytochrome P-450 in this Jekyll-Hyde transformation of foreign substances by the liver, noting the general presence of the enzyme in marine and terrestrial animals, and the ability of the animal body to produce "on demand," by slight structural modifications, versions of cytochrome P-450 capable of dealing with a wide variety of more-or-less hydrophobic, often cyclic, substrates. The reaction mechanism involves NADPH-mediated electron transfer and formation of an unstable enzyme-substrate-oxygen superoxide radical within which hydroxylation or dealkylation of the drug takes place.

The remainder of the 1976 symposium first showed us some of the methods now being used to study enzyme-substrate or enzyme-drug interactions, then illustrated the special difficulties encountered in membrane-bound systems where an elaborate series of precisely timed events proceeds under the influence of hormones, electrolytes, and other substances which enter or leave the reaction zone. While such systems had to be represented because of their importance -- one need only point to the voluminous current literature on Na^+K^+-ATPase, adenylate cyclase, and the various replication enzymes, each of which was the subject of a symposium lecture -- the most fruitful work at the molecular level has necessarily dealt with enzymes of well defined limited specificity which can be studied *in vitro*. Even here, however, it is being realized that the old lock-and-key hypothesis has outlived its usefulness. Perhaps some degree of lability is characteristic of most receptor sites. Even in these relatively simple isolated systems we must not expect the going to be too easy, as witness the existence of low and high activity forms of carbonic anhydrase and the different configurations of some of their enzyme-inhibitor complexes.

It is probably only in these isolated systems that the pursuit of rational drug design offers much hope at present. Two relatively unconventional approaches described at the meeting were, to me, particularly intriguing. Both made full use of the detailed information now available on macromolecular structure and both elegantly turned conventional procedures upside down. Instead of trying vainly to deduce an unknown receptor structure from the nature of its substrates and inhibitors, they chose a particularly well-known region of the macromolecule, defined it as a receptor, and attempted to design a drug to fit.

The first speaker, P.J. Goodford (Wellcome Research Laboratory, Beckenham, UK) selected the site of reversible attachment of diphosphoglycerate (DPG) to deoxyhemoglobin and was able to prepare a derivative of diphenyl ethane which attaches itself covalently and prevents DPG attachment to the "receptor." The point of practical interest, of course, is what the new drug will do to the oxygen uptake curve. Permanent modification of red cell hemoglobin so as to produce desirable changes might prove useful in blood banking and transfusion procedures.

M. Waring (Cambridge) is well known for his work on the intercalation of DNA base-pairs by the flat chromophores of such substances as ethidium bromide and chloroquine. He is now looking for chromophores which exhibit some degree of specificity for pairs of base-pairs and for molecules possessing two or more such chromophores interlinked in such a way as to define the number of base pairs straddled between each intercalation point. The availability of such molecules would make it possible to detect certain sequences in DNA and to block them specifically. The work reported dealt mainly with the related antibiotics echinomycin and the triostins, showing them to be attached to DNA at two points. In addition, an attempt was made to determine the effects of modifying the structure of the ring system connecting the chromophores, and to vary the distance between chromophores by the insertion of methylene groups. This work, like that of Goodford, is probably still in its infancy, with a lot of questions to be resolved before the new probes can be used with confidence.

More details about the remaining lectures presented during the 1976 Symposium will be found in ONRL Conference Report C-13-76. The conference proceedings are to be published later by MacMillan and Company Ltd.
(J.B. Bateman)

ENGINEERING

ANTENNA ACTIVITIES AT THOMSON-CSF: AN AERIAL VIEW

Thomson-CSF is the largest electronics company in France, employing about 50,000 people at many different locations. The technical activities of the company are grouped into five major divisions: research, systems, tubes, components, and data-processing. Antenna work is done within the systems division at Bagneux, a suburb of Paris. Recently I visited Dr. M. Drabowitch, Head of the Antenna Department, who gave me a bird's-eye (aerial?) view of the activities in his department. Drabowitch is also an adjunct professor at the Ecole Nationale Supérieure de Techniques Avancées in Paris.

The Antenna Department at Thomson-CSF has 18 engineers (Dipl. Ing. or higher) and an equal number of technicians. Its activities are divided into five groups: research, tracking antennas, surveillance and multi-beam antennas, electronic scanning antennas (phased arrays), and antennas for special applications (satellite antennas, earth telecommunication antennas, etc.). The Department has its own computers and an outdoor antenna range about 30 km from Bagneux. The range can be used for radiation-pattern measurements over a distance from 400 m to 6 km.

There are also two anechoic chambers for indoor microwave measurements. The chamber dimensions are 3m x 4m x 5m and 8m x 12m x 14m. The large chamber is lined with pyramid-shaped microwave absorbers of 1m in length. It can be used for measurements at frequencies down to 1 GHz. At 3 GHz the reflection is minus 50 dB. A special set-up for measuring the electromagnetic field of aperture radiators has been in operation which uses two open waveguides as the probes in two orthogonal planes for two perpendicular polarizations. Suitable computer software enables the simultaneous determination of field amplitude and phase. A dynamic range of better than 46 dB has been attained.

Considerable attention is being devoted to the study of the radiation characteristics and possible applications of circular corrugated horns. These horns can be made to have better than 30 dB- sidelobes and their phase-center location is nearly constant over the operating frequencies. In addition to using a circular corrugated horn as the primary feed of a satellite antenna, Thomson-CSF plans to use these horns in earth telecommunication antennas and tracking radar antennas. They are less susceptible to depolarization effects and have a low spill-over, resulting in low secondary sidelobes. Low secondary sidelobes are, of course, a desired property for anti-jamming purposes.

Research work is also being carried out on phased arrays of both open waveguides and dipole elements in an effort to predict and avoid blind spots (nulls) in the radiation pattern. The intention is to extrapolate and predict array behavior from the measured data on a few of the elements. It will be necessary to determine whether or not an asymptotic form for the coupling coefficients between array elements exists as the total number of elements in an array increases. Another current study is on Cassagrain antennas with concave sub-reflectors as shown in Fig. 1.

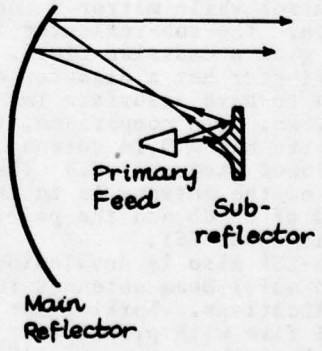

Fig. 1 - A Cassagrain antenna with a concave sub-reflector

Because the rays emanating from the sub-reflector diverge, there will be less reaction on the primary feed, thereby resulting in a lower standing-wave ratio. The problem lies in the

design of the sub-reflector. Consideration must be given to the sidelobe level, purity of polarization, etc. This study is important for small Cassagrain antennas where the available space is very limited.

The Antenna Department of Thomson-CSF has just completed the design of a new satellite antenna which will operate in the new 10.95-14.50 GHz band (10.95-11.70 GHz for transmitting; 14.00-14.50 GHz for receiving). It is of the Cassagrain type. The feed system consists of a circular corrugated horn and four microwave mirrors (reflectors), as shown in Fig. 2.

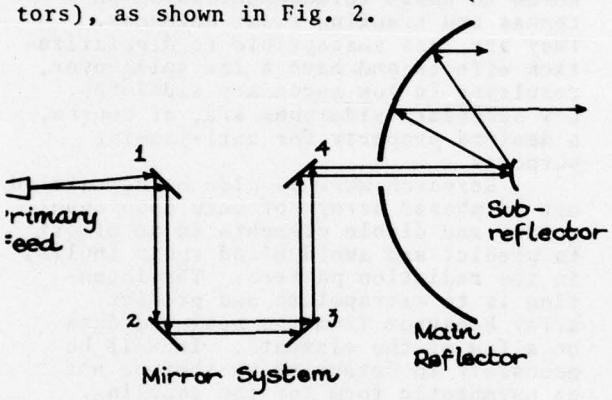

Fig. 2. - A new satellite antenna

Each of the mirrors is about 1m in diameter which is approximately 30 wavelengths. Mirrors 1, 2 and 3 are for aszimuth control while mirror 4 controls the elevation. The sub-reflector is designed to give a Gaussian field. The main reflector has a diameter of 14.5m and is to have a surface rms accuracy of 0.5mm. (In comparison, the ATS-6 satellite has a 9.1m antenna operating at lower frequencies.) The directivity of the antenna is in the neighborhood of 65 dB and the power efficiency is about 75%.

Thomson-CSF also is developing adaptive and multi-beam antennas for special applications. Working for a commercial firm with proprietary interests, Drabowitch was not at liberty to discuss certain aspects of his work. However, it was apparent his was one of the most active groups in France working on antenna research and development. Drabowitch himself was very knowledgeable and was courteous enough to give me an aerial view of Thomson-CSF's antenna work on very short notice. (D. K. Cheng)

IROE--AN ITALIAN ELECTROMAGNETICS RESEARCH CENTER

About 6 km from the center of Florence is located the Istituto di Ricerca sulle Onde Elettromagnetiche (IROE) of the Italian National Research Council. It is the foremost Italian research center on the radiation and propagation of electromagnetic waves. IROE, formerly called Centro Microonde, was founded in 1947 by the now retired Professor N. Carrara. Its present Director is Professor G. Toraldo di Francia who also holds a Chair in Physics at the University of Florence. Toraldo is the author of the well-known early book, *Electromagnetic Waves* (Interscience Publishers, 1953). He is a person of international prominence and has been to the US many times.

At the present time, IROE employs approximately 120 people--roughly one-third of whom are scientists or engineers and the rest are technicians and other supporting personnel. Current projects range from ultrasound applications, digital signal processing, fluorescence in solids, to electronic metrology and integrated optics. On a recent visit to IROE, I was cordially received by Professors Toraldo, A. M. Scheggi, and P. F. Checcacci and many of their colleagues. This article reports some of their work in the electromagnetics area.

Scientists at IROE were among the first to work on microwave holography and holographic antennas. They have experimented with different methods for constructing microwave holograms which are central to holographic-antenna pattern synthesis. They also have built apparatus to reconstruct visible images from microwave holograms by laser light and suggested the use of microwave holographic interferometry to map tides or earth's deformations. A recent work of this group was object-imaging in the presence of uncontrollable aberrations. The purpose was to obtain a correct optical image from a microwave hologram of an object through a random aberrating medium. A basic requirement of this problem was the proper compensation of the aberrated wavefront with a phase distribution characteristic of the medium. The phase compensation was accomplished by multiplying (optically processing) two microwave holograms: one made with the object wave perturbed by the medium and the other with the object replaced by a point source. Satisfactory results

have been obtained. Currently an electronic multiplication procedure is being studied which will allow application to time-variant aberrating media.

Several projects are going on in the integrated optics area. Based on the principle of configuration lenses for application to microwave antennas, thin-film geodesic lenses for guided optical waves have been constructed and tested. These lenses are made of a properly shaped glass substrate, over which a thin dielectric film is deposited. They can be easily inserted in planar thin-film circuits, and the substrate can be prepared in advance with the accuracy of glass optics. One project is the construction of low-loss miniaturized models of particular types of geodesic lenses. A second project is the study of the possibility of making an integrated optical correlator with two geodesic lenses. A third project is concerned with the application of different types of photoresists to integrated optics. Special attention was paid to Kodak Ortho Resist (KOR) which is a negative-working photoresist in that it is soluble in the developer only in areas not exposed to light. KOR has high sensitivity over a wide wavelength range and a long storage life, and its cost is relatively low. Efficient grating-couplers and optical film-guides have been realized. Holograms also have been made on KOR with a resolution better than 2,000 lines/mm. I was guided through IROE's microwave holography and integrated optics laboratories by the former Professor Vera Russo, who is now married to her colleague Professor P. F. Checcacci. So IROE now has two very knowledgeable and productive (certainly in the professional sense) Professors Checcacci.

P. F. Checcacci, Schèggi, and others at IROE were the first to study the properties of the phase-step beam waveguide made of a series of equispaced dielectric frames. Over a period of 10 years since 1966, they published widely on open resonators including the planar Fabry-Perot resonator, the rimmed resonator, the ring resonator, and resonators with flat or 90° roofs. Recently they investigated the modes and mode degeneracy in 90°- and quasi-90°-roof open resonators by numerically solving the appropriate integral equations. A current project is the feasibility study of the optimization of the so-called "Cassagrain resonators." A Cassagrain resonator is constituted by plane mirrors of different apertures with rims along the edges of the mirrors.

Another group consisting of L. Ronchi, F. Pasqualetti and A. Consortin has been working on a new method for analyzing open beam-waveguides, a theory of "noisy" optical images, and the propagation of waves in waveguides with a transverse gradient of the refractive index. When the refractive index is considered complex in such a way that the medium is active, the last problem has relevance in the study of dye laser

In the propagation area, intensive studies are in progress on the space-to-ground propagation channels in the equatorial zone. These studies are a part of international programs using INTERCOSMOS, ATS-6, and other satellites. A receiving station with preamplifiers and converters for the 180-MHz and 360-MHz bands has been designed and assembled. The station is completely computer-controlled and the operations are done with high accuracy with all frequencies derived from synthesizers based on a single oscillator having a stability of 10^{-10}. Measurements of amplitude and phase fluctuations of different signals due to ionospheric scintillation can be made on a real-time correlator.

Starting from the impulse response of the ionosphere measured with signals from beacon satellites, P. F. Checcacci and others numerically determined the ionospheric profile on a computer as an inverse problem. Although only the overall shape and not the details of the profile can be determined by this method, the results are considered to be the most realistic from the propagation point of view as they are obtained from propagation data.

Experimental research on the propagation of a laser beam through a turbulent medium is being carried out in several directions by Consortini and his co-workers. First, the propagation data through an artificial thermal turbulence are being used to determine both the angle-of-arrival of the beam and the essential parameters of bounded layers of turbulence such as those produced by jet planes and by chimneys. Second, a method is being developed for the statistical analysis of the temperature fluctuations under different meteorological conditions in the atmosphere near ground level. Third, efforts are continuing in the construction and calibration of an automatic data-acquisition system from a laser beam after propagation through the

atmosphere and/or through an urban path of fog and air pollution.

As mentioned in the beginning of this article, research projects at IROE cover a very wide range. I have described here only some of the projects that are of explicit relevance to the radiation and propagation of electromagnetic waves. The people I have met are dedicated and are highly qualified, and they are aware of what is happening in the rest of the world in their areas of interest. Their physical facilities are relatively modest, and I did not see an abundance of precision equipment in the laboratories. I was told that IROE suffered a 40% reduction in funding from the National Research Council (CNR) in 1974. In 1975, there was a 10% increase over the 1974 figure. In view of the worldwide inflation and the drop of the Italian lira in the money market, it is not difficult to see IROE's difficulty.

In concluding, I would like to mention an additional project at IROE. In Italy there is now no firm that makes optical fibers. Venetian glass, of course, is world-famous; but, for some reason, its makers are reluctant to do research and development work for CNR. What was IROE to do if it wished to study optical fiber communication and integrated optics? Instead of relying entirely on foreign products, the people at IROE went ahead with a two-pronged attack. On the theoretical side they used the ray-tracing technique to study the dispersion characteristics of graded-index slab-waveguides and graded-index cylindrical fibers. The results of the study have already been published in two recent papers. Simultaneously, they designed and built a fiber-drawing machine in the laboratory. They were justly proud in demonstrating the machine to me by drawing 70-μm fibers from a glass rod. Precise controls of oven temperature, drawing speed, and other parameters are imperative in order to obtain fibers of a desired diameter with an acceptable optical tolerance. Silica fibers can also be drawn on the machine. An experimental bench for the accurate measurement of very low fiber attenuations has been put up. The next step is to design a sophisticated computer-controlled system for making clad fibers. Compared to the best available facilities at installations making optical fibers in the US, what IROE has is relatively primitive. However, high technology was involved in making the machine operative, and the small group at IROE overcame many practical difficulties themselves. I cannot help but admire their ability, fortitude and dedication. (D. K. Cheng)

2ND INTERNATIONAL HEAT PIPE CONFERENCE

The heat pipe is a heat transfer device, basically consisting of a sealed tube lined with porous wick and filled with a volatile working fluid. It has a thermal conductance several hundred times greater than geometrically similar metal conductors. The space program of the 60's saw a great deal of development in heat pipes for use in some very specialized applications. During this period the heat pipe was viewed in many quarters as an engineering curiosity and of very limited real usefulness. In the early 70's many people in engineering were saying that the interest in heat pipes had reached its zenith and was on the wane. Since that time heat pipes and the associated technology have matured. This is the impression that is left after the 2nd International Heat Pipe Conference.

The first International Heat Pipe Conference was held in October, 1973, in Stuttgart. Forty-four papers were presented at this first meeting and a major result was the realization among the "heat-pipe community" that their gathering together was of tremendous benefit and that meetings of this sort should be held every two to three years. Consequently, for the second international meeting 97 participants from 11 countries assembled at the "Palazzo della Cultura e dei Congressi" in Bologna, Italy from 31 March through 2 April. Before discussing the technical content of the Conference, a word must be said about the organization and facilities for the meeting. The new conference facilities in Bologna are some of the finest to be found -- some at the meeting felt they were the finest in Europe. The room used for the Conference can accomodate over 200 participants and is equipped with facilities for simultaneous interpretation. (These interpretative facilities were used only for the opening address by Professur Arturo Giulianin, chairman of the Organizing Committee -- the papers themselves were all presented in English, the official language of the Conference.)

The host committee made all the participants and their guests feel

most comfortable in unfamiliar surroundings, and on Thursday evening we were treated to a concert of Mozart Quintets by the "Quintetto d'Archi di Bologna", in the Mozart Concert Hall of the "Accademia Filarmonia di Bologna." This was followed by a most elegant dinner held in the private "Circolo della Caccia" or Hunt Club. All of this as well as the general helpfulness of the Italian hosts served to foster a feeling of conviviality among the participants and thereby encouraged a good deal of free discussion and interchange.

The conference itself consisted of 79 papers divided into 11 sessions organized to cover the many different areas of heat pipes, from scientific fundamentals to commercial applications. A quick perusal of the conference program reveals an interesting aspect of the distribution of research effort in heat pipes. What I am referring to is the fact that the session on liquid-metal heat pipes consisted of seven papers all of which were from the Soviet Union. Regrettably only one of the Russian authors (L.L. Vasiliev) had arrived in Bologna, which necessitated a major change in schedule. The Soviet papers were all presented by Vasiliev.

The content of the technical sessions was extremely diverse. There were sessions dealing with such areas of heat pipe fundamentals as dynamics, materials, and evaporative heat transfer. Other sessions were concerned with the many different types of heat pipes currently being developed, including high-temperature liquid-metal heat pipes, low-temperature heat pipes, variable-conductance heat pipes and wickless rotating heat pipes.

The session which held the most general interest was the one dealing with Terrestrial Applications. (The use of the word "Terrestrial" in this session title may seem a little strange but it is still necessary to show a distinction from "Space" applications. Reflecting a great useful potential for heat pipes, the session showed how they are being used to solve some of the more vexing heat-transfer problems which have been with us for quite a while, as well as some of the newer problems which have arisen by virtue of new technologies (microelectronic circuits) or new priorities (energy utilization).

Two papers were presented which dealt with the use of heat pipes in de-icing systems. The first of these, "Application of Heat Pipes to De-icing systems," by H.J. Suelan and E.J. Kroliczek (B&K Engineering, Inc., Towson, MD), was concerned with the use of heat pipes in pavement de-icing. The authors described a system utilizing the stored energy in the volume of the earth in the vicinity of the pavement surface. This form of stored energy is a low-grade or low-potential thermal energy source, since the source (the earth) is at a temperature very close to the energy sink (the pavement ice). Heat pipes with their very low thermal resistance are ideally suited, as a transfer device for this type of low-potential thermal energy. The paper of Suelan and Kroliczek presented designs of de-icing systems using heat pipes for three critical situations where frozen pavements present high safety risks: highway bridges, interchange ramps, and airport runways.

The second paper dealing with the use of heat pipes in de-icing systems was titled, "Self De-icing Navigation Buoys Using Heat Pipes," by B.S. Larkin (National Research Council, Canada) and S. Duboc (Canadian Ministry of Transport). Apparently, ice formation on navigation buoys off the east coast of Canada can be a serious problem. Ocean spray combined with low air temperature can cause ice to build up to such an extent that the buoy capsizes. The authors presented a design in which the superstructure of the buoy would be constructed as an ammonia heat pipe. This would allow the transfer of stored energy from sea water to be used to melt the ice as it forms, again using a heat pipe to transport low-grade thermal energy. The authors have performed laboratory tests which demonstrated the feasibility of the concept, and they are presently field-testing a prototype buoy in the ocean off the coast of Halifax, Nova Scotia.

Another, quite different application was presented by D.J. Dean of the Microcircuit Technology Group AWRE, Aldermaston, UK in his paper, " An Integral Heat Pipe Package for Microelectronic Circuits." In this paper, Dean describes the design of an integral heat-pipe system in which a hybrid microcircuit chip acts as the evaporator surface of a flat heat pipe. This design eliminates the conduction and contact thermal resistances which would be present if the microcircuit were bonded to a normal heat pipe wall. With heat sources of such small physical size, these resistances can be a large part of the total thermal resistance. Although the author's

experimental results are tentative, it is my opinion that this design shows great promise in aiding in the solution to the problem of cooling microcircuits.

I would like to make brief mention of the paper, "Follow-up on Heat-Pipe Applications," by A. Basiulis (Hughes Aircraft Co., Torrance, CA). Basiulis has for many years been one of the leaders in developing new and different applications for heat pipes. In this paper he gives very short summaries on the status of some of the latest heat pipe applications such as cryosurgical probes, flexible heat-pipe garment cooling, and electronic module cooling.

This session also included several papers on heat pipe heat exchangers for use in waste-heat recovery systems. The low thermal resistance of heat pipes make them well suited for this application.

It is apparent that workers in the field of heat pipes and heat pipe technology have come to realize not only the true potential of heat pipes but also their limitations. The boundaries of the field and the areas of intersections with other technologies are both becoming much better defined. The technology is maturing.
(M.D. Kelleher, Naval Postgraduate School, Monterey)

THE ONR SYMPOSIUM AT UCL -- AN OVERVIEW

The Eleventh Symposium on Naval Hydrodynamics was held at University College London (UCL) on 28 March - 2 April 1976. Informally referred to at UCL as the "ONR Symposium," the Eleventh is an appropriate representation of ONR goals as the Office celebrates 30 years of fostering scientific exchange. There were representatives from 25 countries, with authors from 12 countries presenting the 40 papers. Abstracts of all papers and the preprints of many were available at the meeting. The volume of Proceedings, to be published by UCL, is expected within a few months.

The symposia now alternate quadrennially across the Atlantic, and the Eleventh was generously hosted at the UCL by Professor R.E.D. Bishop and ably administered by Drs. A. G. Parkinson and W. G. Price, all of the Department of Mechanical Engineering. In addition to joint sponsorship by ONR and UCL, the Symposium received support from the Admiralty Experimental Laboratory at Feltham. Stone Manganese Marine, Ltd., maker of more than half of the world's ship propellers, also assisted generously with a tour of their propeller works in Birkenhead.

Bishop, head of the Department, is rapidly becoming a figure in the field of ship structural response in the broad area of sea-ship-structural interactions which occupies the research and engineering interests of major contributors to ship hydrodynamics. Having taken degrees at MIT and Stanford University, he has been at UCL for two decades, and has led the Department into a broad spectrum of mechanical vibrations research. The growing Department now has a teaching staff of 28, including four full professors, for 110 undergraduate students and 16 graduate students. A curriculum in naval architecture was established six years ago, and in April 1974 Bishop hosted a conference on the dynamics of marine vehicles and structures in waves which became the germ of the UCL invitation for the Eleventh.

Changes have occurred in London which affect even the casual symposium participant. Signs are encountered in all public places, and in the Underground (subway to Americans) there is the ever-present notice: "Look out for any unattended packages or bags. If you see one report it at once to the London Transport staff. Keep all luggage with you." The Eleventh was opened with the admonition that all briefcases be carried, even to coffee and lunch, and that none be left in the auditorium or hallway. The steady nerve of Londoners had a weak analogy in the stalwart progress of many ship architect and hydrodynamicist participants who face an uncertain economic climate of shipbuilding.

During the week of the Symposium, the London Times reported many supertankers laid up and some new ones going directly from shipyard to anchorage. In many instances, construction was conceived and agreed upon based on projections of world oil consumption before the embargo. Now, some Middle East countries are buying new tankers, rather than these ships, and buying from other than the usual suppliers of supertankers. The friendly and spirited competition that has characterized the representatives of model basins, towing tanks, computerized

design centers, and naval architects in past symposia had an added ingredient of apprehension this time, as indicated by emphasis on improved efficiencies and on a more comprehensive approach to hydrodynamic design.

In the past these proceedings have served to record the establishment of a scientific basis for the design of ships. Theoretical and empirical modeling have contributed to the methods of computerized design, and experimental technology has evolved into a highly reliable method of validating new concepts. Additional benefits have been found in more accurate descriptions of the sea as a basic input into ship response prediction. Underlying all the symposia has been the significant advances in fundamental hydrodynamics. The identification and delineation of important parameters in sea-ship-structure interactions have progressed steadily amid work on very difficult problems associated with moorings and replenishment at sea, maneuvering in shallow water, and the development of new forms of marine vehicles.

The Eleventh emphasized hydrodynamics, structural dynamics, unsteady propulsion, maneuvering in a seaway and in shallow water, unconventional marine craft, and experimental techniques. Some of the highlights included a family of planar motion techniques and mechanisms, improved accuracy in full-scale testing, significant advances in the theoretical bases of models, structural response prediction, and propeller-induced problems. The theme of unsteady hydrodynamics was recognized and considered as a major problem by the great majority of the authors, and contributions indicate a strong effort for progress in this subject. Unsteady potential flow was treated as well as the case for unbounded (free surface) flow. Theory and calculation methods were given for unsteady slender-body flow. The Green's Theorem methods were thoroughly dealt with--to the delight of many and as a closing chapter to some. Both elegant and simplifying finite and hybrid element methods were presented. In other areas, such as cavity flow, problems were still apparent and difficult, especially in the unsteady case. The Proceedings of the Eleventh will show a continued maturing of naval hydrodynamics in the capacity to compute ship motion. (B. J. Cagle, ONR/Pasadena)

THE VON KARMAN INSTITUTE - TWENTY YEARS OF EXCELLENCE IN FLUID DYNAMICS

In Brussels, at the von Karman Institute for Fluid Dynamics (VKI), a commemorative plaque reads, "Dr. Theodor von Karman (1881-1963). Dr. von Karman was President of the Board of Directors of the Institute from its inception (1956) until his death. He was passionately devoted to the cause of international cooperation in science and education, [and] this Institute with its students from the NATO countries is a worthy monument to his endeavors." Convincing support for this statement is to be found in the contemporary literature, including the series of notes and reports in which ONRL has documented the continuing progress in fluid dynamics at the VKI. This note briefly describes the current situation and is intended to be an update of the ONRL coverage begun in 1962 by A. Roshko (ONRL Report 48-62) and most recently augmented by D. F. Dyer (ESN 26-12:318). On the occasion of its twentieth anniversary, the Institute has published a review of its facilities and programs, titled "Education and Research, 1956-1976." This excellent publication is highly recommended to the interested reader.

In addition to the natural attractions of the VKI, my visit was motivated by an invitation to attend the short course titled "Computational Fluid Dynamics." (The nature and content of this course will be described in a separate report now in preparation.) The current VKI interest in computational fluid dynamics is indicative of the manner in which the Institute continues to adjust its programs to match the ever-changing needs of the users of research in fluid dynamics. The VKI is now organized into four Departments, only one of which, the Aeronautics/Aerospace Department (headed by Prof. J. F. Wendt), has roots which extend to the origins of the Institute. The Department of Turbomachinery (Prof. J. Chauvin) was established in 1960, and viewers of the "passing scene" in fluid dynamics will easily understand the logic behind the 1972 reorganization which led to the formation of two additional Departments: General and Environmental Fluid Dynamics (Prof. J. J. Ginoux, who is also the Associate Director of VKI) and Computational Fluid Dynamics (Prof. H. J. Wirz). The day-to-day

activities are presided over by the Director, Prof. J. J. Smolderen, and long-term guidance and support is provided by an international Board of Directors chaired by Prof. A. D. Young of Queen Mary College, London. The operation also is closely coupled to that of AGARD both in the selection of students for study at the VKI and, of course, in the exchange of information with the AGARD Fluid Dynamics Panel.

The faculty (which is also the research staff -- a noteworthy equation) has grown from only a few in 1956 to the present number of 15. Since 1962, however, the total staff has remained nearly constant at about 75. Thus, the VKI appears to have managed to maintain -- and in many cases expand -- a broadly-based research program while avoiding a simultaneous influx of personnel. Marked changes in the funding basis have occurred during the past few years, with the current budget of about $1.5M being provided from research contracts (25%), the Belgian government (15%), and 13 other contributing nations (60%). Previous ESN reports have amply described the fiscal pains associated with transition from the "friendly 50's" to the "savage 70's." The significance of the current economic picture at the VKI is illustrated by A. A. Ranger's observation in 1971 (ESN 25-9:280) that at that time Belgium was supplying 52% of the budget. In 1972 Dyer said that Wendt "did not project any feelings of despair," but my impression is that Wendt's (and VKI's) current economic morale projects positive optimism.

The VKI approach remains today as it has been throughout its history -- a strong educational program (diploma and doctoral courses, lecture series, and special courses) which is intimately coupled with theoretical and experimental research projects in fluid dynamics. Since 1957, VKI diplomas (one academic year with 60 credit hours plus a major research project) have been awarded to 388 graduates from 14 NATO countries, and, since 1963, 29 doctoral degrees have been granted. Currently there are about 50 students enrolled in the Institute.

The anniversary publication contains up-to-date and comprehensive descriptions of the current VKI activities and facilities. These will not be paraphrased here, but two of the most recent facilities developments are especially worthy of mention. The first of these is the major modification to the low speed wind tunnel to allow for the increased need to simulate flows past buildings, bridges, and other structures. VKI has contributed significantly to the current understanding of atmospheric surface flows (see, for instance, the lecture series titled "Wind Effects on Buildings and Structures," LS 45, D. Olivari, Feb. 72), and the current tunnel modifications are to permit extended upstream regions in which the flow can be tailored to more adequately model the atmospheric surface layer.

The second important expansion of the VKI experimental capabilities is the construction (currently underway) of the Compression Tube Tunnel, CT-2. The philosophy of operation of this tunnel (and its smaller predecessor, CT-1) draws heavily on experiences accumulated during extensive aerospace-related studies using free-piston tunnel drives to attain hypersonic speeds. (Just as dimensionless groups have been of enormous value in characterizing flow problems, they seem to be useful in describing trends in research -- Mach numbers of interest have decreased and emphasis has shifted to the attainment of high Reynolds numbers.) The flow in the CT tunnels is generated by the motion of a massive piston, and provides test durations of up to one second at temperatures of 300 to 1000K and Mach numbers of 0.2 to 1.7. Due to compression of the test gas, however, operation at up to 20 bars is possible with unit Reynolds numbers of about 5×10^7 per meter. The CT-2 tunnel will have a test section of one-meter in diameter, thus providing a unique capability of high heat transfer rates at very high Reynolds numbers -- long an elusive goal, especially for simulation of turbine flows.

In summary, I can report that the VKI has managed to maintain its lofty institutional standing in spite of the many challenges that it has faced during its birth and adolescence -- several of these challenges have been unique to VKI as a multi-national establishment and all of them have been superimposed upon a fluctuating research economy. Perhaps a major contributing factor to VKI's success has been the continued emphasis upon educational goals, with attendant multiple benefits, not the least of which has been the active participation of high quality students, from throughout the NATO family of nations, in every VKI research program.

As R. A. Willaume, AGARD Director of Plans and Programs, has stated in his recent review of VKI progress ("The von Karman Institute Celebrates its 20th Anniversary," AGARD Highlights 76/1), "The NATO Nations who have been wise enough to invest in this project have shown that their judgement was right. The benefits that they have received in return cannot be evaluated in francs, dollars, pounds or marks, but only in the seeds that have been planted for a closer scientific and international understanding. Certainly in the years to come this will be seen as one of the most significant examples of scientific cooperation in the free world. All the Professors and the Staff of the VKI should be proud of what they have done. AGARD will spare no efforts to continue to provide them with support, understanding, and friendship." (R. H. Nunn)

MATERIALS SCIENCE

MATERIALS SCIENCE AT HEBREW UNIVERSITY

To anyone familiar with the excellence of the classics and pure scientific departments of the Hebrew University, a School of Applied Science and Technology might come as a surprise. But, in fact, there is emerging within the University a group of first-class scholars who are very much dedicated to developing fields which have direct relevance to Israeli industry. The current director of the School is Prof. D. Frohman-Bentchkowsky, a specialist in microelectronics. The School gives only graduate degrees, principally at the Masters level. The PhD degree is administered by the University and not by the School. The arrangement is thus complex, but the result is an outstanding doctoral student. The University closely guards its reputation of excellence, and one has the feeling that it recognizes that there can be excellence in technology as well.

The School is made up of eight Divisions: Applied Mathematics, Applied Physics, Applied Chemistry, Materials Science, Polymers and Textile Chemistry, Applied Microbiology, Applied Hydrology, and Human Environmental Sciences, clearly reflecting an interdisciplinary effort.

While an examination of the curricula for the above programs gives the appearance of the currently popular, "One from column A, one from column B" approach, it must be said that the Divisions are well planned - perhaps excessively.

The specified objective of the MSc program is "... to train applied scientists for employment in industry and R&D institutions." The basic program is of two years' duration, but may be continued to a PhD degree program for select students. The degree requirements consist of three parts: lectures and laboratories (750 contact hours!); industrial experience (in the form of supervised summer employment); and a thesis. The required courses for the Materials Science division are: Economics and Administration, Industrial Colloquium, Mechanical Engineering, Electronics, Materials Science, Phase Transformations, Theory of Imperfections, Materials Processes and Applications, Experiments in Materials Science, and Seminar. Students take all of these courses! The pain is somewhat diminished due to a quarter system, but the work load and the amount of required material are very real. While all of this might appear to be an overkill, it should be noted that most of the students do not come from a metallurgical or materials science background, so a significant amount of retreading is required. Also, there is the sense of quality that pervades the University.

On the matter of the high number of contact hours required for the Masters degree, some of the faculty indicated to me that the professors tend to emulate the German university style, talking at the students, relating facts and expecting subsequent regurgitation on-call. In fact, one instructor said that there was surprise on the part of the students when he had asked for numerical solutions to a set of examination questions. Nonetheless, Applied Science and Technology is vigorously developing and gaining recognition within the University and among the academics and industrialists in Israel.

The Materials Science Division was founded as a result of the perseverance and vigor of Prof. Michael Schieber, a specialist in crystal growth and the principal editor of the *Journal of Crystal Growth*. Currently, the Head of the Division is Prof. Floyd Tuler, who left a vice-presidency at Effects Technology in Santa Barbara to join the University. Tuler has been in Israel for about 18 months and

currently is establishing a research program on mechanical metallurgy. Other members of the faculty of this growing group include Prof. M. Perakh, (in a former Russian life known as Poperka), who specializes in electrochemistry and is the author of the volume *Stress in Thin Films*. Dr. M. Oron, who is on leave with the Israeli Army, a physical metallurgist with strong leanings towards improving the techniques of electron microscopy, and microprobe analysis. Oron's other active programs include the structure and magnetic properties of hot-pressed powders and the development of a computer-controlled digital system for x-ray powder diffraction. Dr. Z. Kalman,who also is associated with the Institute of Physics, is an x-ray spectroscopist.

Relative to the research program within the Division, Schieber's is currently the most active and the most visible. He has a wide-range of well-supported programs from chemical vapor deposition-formed protective coatings, through phosphates, to crystal growth of single crystals for electronic applications, and more recently, high-Z semiconductor neutron detectors (e.g., HgI_2). The phosphate work is supported by a US-Israel Bi-National Science Foundation grant, performed jointly with workers in the Dept of Materials Science, State University of New York, Stony Brook. In this program, efforts are being made to develop some industrially feasible applications for the abundant phosphate rock available in Israel. Phosphorus is an important fertilizer, but the phosphorus in the rock is mainly in the form of fluoroapatite, which is very stable and not easily available to growing plants. The problem is to form a completely soluble fertilizer, which is generally accomplished by thermally reacting the fluoroapatite with magnesium chloride. The product end, however, is not yet optimum. Thus, the study. Early in this program a novel method was developed for getting rid of the fluorine and obtaining soluble high quality magnesium phosphate fertilizer. First, the fluoroapatite is reacted with $CaCl_2$ yielding chlor-spodiosite (Ca_2PO_4Cl), which is reacted with $MgCl_2$ giving magnesium-chlor-phosphate (Mg_2PO_4Cl) and $CaCl_2$. The Mg_2PO_4Cl can yield phosphorus to the soil, and hence the goal is achieved. Currently, Schieber, together with a graduate assistant, Mehama Faibis, is examining the detailed kinetics and thermal dependencies of the reactions, so that optimum reaction schedules can be achieved. It should be noted that in using the process it is possible to increase the phosphorus yield from 37% for fluoroapatite to 93% for Mg_2PO_4Cl. Israeli cows are being fed this compound in order to increase their magnesium intake.

Schieber's crystal growing techniques are simple and highly effective. Although he has available a wide range of methods, his group has been concentrating more recently on vapor growth. He discussed the importance of high-Z radiation detectors for both biomedical and military purposes. An important example is HgI_2, for which it is possible to detect gamma-radiation from 150-500 keV. Using a sublimation growth method, he is growing high-purity HgI_2 crystals of up to 100 g.

Tuler received his PhD from Cornell, where he studied aspects of mechanical properties at high pressures. In the US, Tuler had been involved with instrumented fracture testing, but has now begun research on low-cycle fatigue. He will attempt to relate cyclic mechanical properties to fracture properties and microstructure. Some work of this sort had been done at the University of Illinois by Prof. Morrow, under whom Tuler did research for his MS degree. There is obviously some relation between the plastic zone in the vicinity of a fatigue crack and the propagation of that crack. Tuler feels that only the surface has been scratched and much more ought to be done. He also has underway programs on non-destructive testing and the mechanical properties of composites.

Another area of great interest to Tuler, experimentally related to the above, is instrumented fracture-testing. He believes that it is essential to question the dynamic toughness tests which today are considered standard. He also is consulting for the Israeli aircraft industry and other groups. Tuler is starting a joint program with an industrial organization on the currently popular topic of hard-particle erosion. The test-program parameter matrix which they are considering is most comprehensive and will warrant attention in the future.

The major job facing Tuler, however, will be the academic program within the Division, and the latter's relation to the School and the University. An article was published in the *Jerusalem Post* just several days before I visited the campus entitled: "Israel's Higher Education Must Come Down to Earth." It was based upon an

interview with visiting American university presidents who contended that Israel has some of the finest academic institutions in the world, but they are not oriented towards helping the nation's economy and industrial development. The most potentially devastating and quoted statement was attributed to Dr. Robert Wood, President of the University of Massachusetts, who said: "We were fascinated by a Mandarin posture in a Spartan state." This, though rebutted shortly thereafter by the President of the Hebrew University, has hit home among many of the Materials Science faculty with whom I spoke both at the Hebrew University and at the Technion. In particular, Tuler and his colleagues recognize these problems and are clearly setting about rectifying them. (H. Herman)

METEOROLOGY

ATMOSPHERIC TURBULENCE NEAR THE EIFFEL TOWER

The Establissement d'Etudes et de Recherches Météorologiques" (EERM) consists of a number of laboratories some of which, with the head office, are located in Paris, not far from the Eiffel Tower.

The EERM is divided into seven subunits or research teams, which include the following: sea-air interface studies and the prediction of sea state; satellite and stratospheric meteorology; development of atmospheric numerical models; development of meteorological sensors and instruments; operational weather forecasting; "blue sky" meteorological projects; and the study and forecast of avalanches and problems connected with ice and snow. The Laboratory has about 200 scientists, and its budget, exclusive of salaries, for 1975, was about FF 2×10^7 ($\$5 \times 10^6$). It has as its mandate the observation and prediction of atmospheric motions. Some of these atmospheric observations are used for environment control via the monitoring and modeling of pollution at low and stratospheric levels and in the monitoring of atmospheric water vapor in the troposphere. Most of these functions are carried out with other French laboratories like the "Centre National des Télécommunications" (CNET) and its research laboratory "Le Centre de Recherches en Physique de l'Environnement" (CRPE) (see ESN 30-5:231) and as part of international and multinational programs with the US or the USSR.

I visited the "Groupement de Météorologie Dynamique" (GMD) which deals with the development of numerical models for short range weather prediction; global atmospheric models; and models of turbulent flows, in particular those flows found in the turbulent atmospheric boundary layer. Dr. J.C. André, who spent a year at the National Center for Atmospheric Research (NCAR), in Boulder, and some of his coworkers are becoming known as specialists in turbulent flows. André has done work on three-dimensional turbulence but, in the past year, his group has turned its attention to models of atmospheric boundary layer flows.

Turbulence is still a wide-open area for research in fluid dynamics, in meteorology, and in a number of other fields. "Closure" is the central problem which plagues all theories on turbulence and comes about because there are more unknowns than we have equations. More specifically, if we form the n^{th} correlation of the fluctuating quantities the resulting equations will contain the $(n + 1)^{th}$ correlations. To have as many equations as there are unknowns, we must truncate the system of equations at some order and introduce a further hypothesis called the closure assumption.

At present, such an assumption can be of two kinds. The first is based on a semi-empirical approach which relates low-order correlations, $n=2$, to mean flow gradients via positive eddy coefficients. Although very useful in a number of geophysical problems, such a hypothesis might sometime lead to non-physical situations in which the effective eddy coefficient becomes negative! In the past decade one has witnessed research on higher order closure schemes i.e., $n > 2$. It is hoped that by going to a scheme with $n > 2$ the resulting equations will be more accurate than those obtained for $n = 2$. One such scheme is called the "quasi-normal approximation"; it relates fourth-order correlations to second-order correlations, after one assumes that the fluctuating velocity is a Gaussian random variable. Unfortunately, this scheme leads to negative energies, a most undesirable situation! André and his co-workers

have constrained the quasi-normal approximation by means of an inequality which the fluctuating quantities must satisfy. This way they ensure that the magnitude of the terms responsible for the formation of negative energies remain bounded. This closure scheme was named the "clipping approximation." They tested this scheme using experimental data on turbulent penetrative convection obtained from measurements made, in a large tank of water heated from below, by J.W. Deardoff and G.E. Willis, two American scientists from the National Center for Atmospheric Research in Boulder. In the water tank a uniform mean temperature profile was established to a depth of 50 cm and temperature increased with height in the remaining 20 cm. At the start of the experiment a known heat flux was imposed at the lower boundary. André's model, using the clipping approximation, yielded vertical profiles of heat flux, vertical velocity variance, temperature variance and vertical kinetic energy which were in good agreement with the observations. The formulation of the clipping approximation as well as the numerical simulation of penetrative convection discussed above are to appear soon in the *Journal of Atmospheric Sciences*.

The success in the above simulation is encouraging, and André and his colleagues plan to extend the model to conditions prevailing in the atmospheric boundary layer. Thus, although this laboratory is supposed to deal primarily with applied research, most of the applied research, here and elsewhere in France, can be quite theoretical. (A. Barcilon)

MISCELLANEOUS

THE NAVALIZATION OF AN ACADEMIC

Although it certainly is no prerequisite for the job, I like the sea and ships. By far the most technologically advanced class of ship is the nuclear submarine. From the pressure hull - both in form and material to the high density of power and electronics, this immense undersea system is awe-inspiring. So it was with great excitement that I was able to visit Holy Loch, Scotland, to view first-hand the submarine fleet's maintenance and operations procedures.

The Spring trip from London by train through the heart of England, by way of the beautiful dales of Yorkshire, terminated almost surprisingly in the dinginess of Glasgow. From there my colleagues and I traveled by Navy car - and a ferry ride - to Dunoon, a delightful village adjoining the fjord-like natural bay called Holy Loch. Situated peacefully in the middle of the Loch is the submarine tender, USS HOLLAND, and surrounding her - like the lambs I saw from the northbound train suckling at their mother - were the black uppermost visible portions of the most formidable war force known to man, the ships of the US Navy ballistic missile fleet.

The crew of the tender which so ably services the submarines are a classic mix of young seamen and old salts, both clearly of the greatest competence. These men, using the modern approach of "engine health maintenance," have developed a highly effective program of monitoring engine lubricants at carefully planned intervals. Standard lubricant testing methods are employed, including spectroscopy and the more recent technique of Ferrography, in which fine metallic debris, carried by the lubricant, is magnetically separated and examined microscopically. The sizes, color and form of the debris enable a prognostic approach toward engine failure prevention. This approach is particularly important in high performance systems such as a submarine. Lubrication monitoring, together with standard acoustic tests, and an extensive nondestructive testing laboratory, manned by highly capable technician-seamen, permits the Navy to maintain a vast submarine fleet at sea for remarkable durations.

This monitoring program, though impressive, was not the high point of my visit. Rather, in a strangely haunting way, it was something else that attracted me to these ships and their crews. These men are obviously dedicated, first class technicians and engineers. They convey a sense of high ability and trust.

And the ship (or, for those of WWII vintage war movies, the boat ...) is something special. Its very complexity, its interconnected mass of systems heaped upon systems, with redundant networks supporting and being supported by more networks, add an extra, perhaps indefinable quality to the ship. I was especially impressed

by the engineering officer - who appeared to understand the function of every pipe and connection - describe in great detail this superb product of human ingenuity. This kind of relation between man-and-machine has since the Industrial Revolution been philosophical food-for-thought. I, for one, would not have the temerity to suggest that a machine has anything approximating an "entity" of its own. I do feel, however, that man-plus-machine represents something larger than their sum. What this quality is, I do not know. But the submarine within which I walked exuded this man-machine quality, to the extent that, to me at least, it no longer took the form of only a complex device, but, rather that of an instrument of symbiosis. In fact, it is almost possible to forget the real reason for its existence.

Holy Loch represents one of the numerous naval and ocean-oriented activities which I have had the opportunity of visiting this year. From obvious military to clearly commercial ventures, Europe is buzzing with plans and building. The energy-related activities of Holland and the UK (wave power, tidal power, etc.), the offshore industry of these countries as well as of Scandinavia, are remarkable to behold. Conferences proliferate on offshore technology of every kind, and industries are developing with a surprising vigor in the midst, frequently, of economic stagnation. University departments of ocean engineering have been spawned, supported by government and industry. Diving schools are opening under the scrutiny of the governments, and now in the case of Britain, with the cooperation of the government. Arguments on welding wet vs welding dry -at great depths -go on, with the payoff being large for the winners - all in the midst of too many unknowns. Pollution, aquaculture, offshore factories, etc. ...!

Meanwhile men go deeper. COMEX, a diving contractor headquartered in the South of France does first-class research on deep diving and agressively penetrates to greater depths in the North Sea as well as world wide. The British have pioneered a different concept -BIG JIM - an articulated self-contained diving suit - really a system in which the diver stands within a metal casement which can walk and manipulate and perhaps will eventually go to several thousands of feet below the surface, and all within one atmosphere of pressure, thus avoiding the dangers of saturation diving. The implications for submarine escape schemes are obvious.

The list is almost endless. The ocean technologies of Europe have been discussed in these pages for a long time. But the central point that I should like to make here is that we ought to perhaps pay more attention to these European activities and to examine our engineering expertise and potentials vis-a-vis the sea-surface and subsurface --- to be alert for new opportunities for research and industry.

Ocean technology is a complex, multidisciplinary field. It can give a middle-aged engineer a new lease on life, and tired fields new challenges. It can also, I believe, help to attract young people to the study of engineering. The sea, though this is by now a truism, is indeed the last frontier.

So, in spite of some sea-sickness, I hope to continue on a wet approach towards engineering. As stated in a recent book by ADM. E.R. Zumwalt, retired Chief of Naval Operations, "... the United States is...a "world island" whose every activity is bound up with the use of the seas," and "the economy of the United States requires that she have a large maritime capability." These, too, are truisms.

The thoughtful and intelligent use of the sea's resources is essential. The economic and political aspects of obtaining these resources is tied inextricably to technology. One must hope, however, that as in so many areas of science and technology these days, the US does not fall behind after being so used to being ahead. (H. Herman)

ONRL REPORTS

See the back of this issue for a list of current abstracts, and how to obtain the reports.

OCEAN SCIENCE

ON KEEPING OUR BOTTOMS SMOOTH

International trade is largely dependent on cargo ships and tankers. And keeping these vessels moving dependably, rapidly, and economically requires clean and smooth bottoms. This is the problem that brought together some 160 representatives of government and industry to attend the "2nd International Ship Painting and Corrosion Conference" in Amsterdam during the 11th and 12th of March. The attendees were principally from the UK and the Continent, and mainly in one way or another, involved in offshore petroleum technology. Only 12 papers were presented, which left plenty of time for an energetic exchange of views. The main issues involved long-term (3-year) paint systems, economics and pollution. These three complex and closely related problems were discussed extensively and with a great deal of candor. I should like to briefly review the high points of the Conference here and relate some general impressions.

The overall message was that the high cost of fuel has increased the need for smoother underwater surfaces, since biofouling will greatly reduce efficiency. In the opening address, W.D. Brouwer (Vice President and Managing Director, Shell Tankers of Holland) stressed that this problem has become especially severe for ships docked in highly polluted harbors where stagnant warm water can modify the types of the fouling populations. Brouwer (who admitted never to have himself "... painted a ship longer than 30 feet") outlined something of the tanker business and the daily problems and frustrations with which tanker operators must live. Royal Dutch Shell owns and operates 50 tankers, manned and maintained by 2500 employees. Recently, due to excess tanker tonnage (resulting from a generally poor world economic scene and over-enthusiastic building) Shell has been experimenting with converting tankers to grain carriers -- with some success. In an effort to keep the fleet and crews working during this lull in business, they also are employing a number of tankers for mooring experiments: A tricky operation which looks easy on paper, but where in actuality, like almost anything at sea, Murphy's law reigns supreme. Brouwer feels that tanker builders, owners and operators will have to make a gamble on future economic growth - the sea-going fleet will have to expand, or there will be an inadequate tanker fleet to meet the expected economic upturn when it arrives. (It should be noted that there were some attendees who privately stated that the very large tanker is headed for extinction -- I'm sure with accompanying cheers from ecologists.) A central aspect of keeping the fleet moving is economics, i.e., the cost of surface preparation and painting, how often it must be done, which paint should be used for a particular kind of service, etc. These were the issues that Brouwer introduced and which the subsequent speakers discussed.

G.S. Mole (Group Manager, Technical Services and Engineering, P&O Co.) generalized on the problem areas faced by ship operators: pollution, economics and an expanding marine technology. Mole frankly admitted that industry is not paying enough attention to problems relating to pollution. In the shipping industry these problems are subtle, but sometimes dramatic, such as serious oil spills. It frequently is the latter that opens everyone's eyes to the reality of environmental factors. Mole freely discussed confrontations with ecologists and politicians who are attempting to improve our environment, and with the resulting legislation which must be accepted by industry. The problem, however, is very involved. For example, cleaning up harbors will introduce new populations of biota that are resistant to existing antifouling paints.

To propel the ships through the sea with acceptable economics will require going to new antifouling compositions, and these, he fears, will have an increase in heavy metal compounds. Pollution problems are caused not only by leaching of the toxins by the sea water, but also in air by spray application in the shipyard. Japan (motivated mainly by union pressure on government) now has strict regulations controlling the use of certain toxins in antifouling compositions. Relative to future worldwide legislation on this matter, Mole said, "For antifouling paint, however, the toxic quality of the heavy metal compounds is essential for successful protection of the hull and unless equivalent alternative compounds can be found, it would appear that a head-on

clash between this requirement and legislation is inevitable." Mole also said that "The existing world economic problems are well known to all; and few countries have not been affected in one way or another by the change in fuel prices and economics which have been introduced." The punch line is that heavy metal toxins and stringent pollution regulations seem to be incompatible and therefore research on new and acceptable paint compositions is essential.

J.D. Scantlebury (Lecturer in Corrosion Science at the University of Manchester Institute of Science and Technology) gave an essentially tutorial lecture on marine corrosion and its prevention. His clear, and well-illustrated presentation was aimed at dispelling the concept of an easy solution to the complex marine corrosion problems. In this he succeeded admirably.

Scantlebury discussed the frequent problems that are encountered with stainless steels, from pitting corrosion to crevice corrosion, and reviewed some research efforts in these areas. Corrosion protection by alloying, though apparently effective, frequently has its limitation. For example, a Corten steel used for a floating pontoon showed uniform corrosion above the waterline, but pitted severely below the waterline. This was a surprising and very expensive error. While cathodic protection and organic coatings are the old standbys for corrosion protection, in the latter case, it cannot be stressed too strongly that primers are of the greatest importance. Scantlebury reviewed new paint systems in very general terms, and - in an unusual and refreshing approach for an academic - placed the use of these paints in the realistic context under actual, adverse conditions rather than just in laboratory conditions.

In two papers A.O. Christie (International Marine Coatings, UK) and H. Ohnemus (Hempels Marine Paints Co., Ltd., Copenhagen) reviewed advanced antifouling systems. Christie discussed self-polishing copolymers (SPC). A laboratory curiosity not so many years ago, this coating system currently is being marketed worldwide. The composition offers the following advantages: smoothness, which under dynamic conditions, can be continuously renewed and biologically reactivated, the antifouling lifetime being proportional to the thickness of the coating. The roughness is reduced significantly due to the operation of a differential polishing rate (the roughest peaks get smoothed out faster); and subsequent recoating can be applied with no apparent loss of the previously applied SPC.

In his talk on a "dynamic paint system," Ohnemus outlined the basic principles upon which this system is based, and alluded to the early work on drag-reducing polymers as well as to some of the laboratory measurements which were made. Following this he discussed some of the economics of the situation.

One was left with the impression from these two papers that if the surface is prepared properly, the supports for the painters are conveniently erected, the personnel well-trained, the weather perfect, you should get a good coating that will live up to specification. This need to apply paint under controlled conditions was stated again and again, but was especially emphasized by these two speakers relative to high performance coatings.

Other papers covered the more mundane aspects of the problem; reactivating antifouling paints from the point of view of the ship owner; coating procedures and safety precautions in the shipyard; guarantees (J.A.R. Gilbert, Nicklin and Co., quoted an old "law": "...for 100% coating project efficiency, at least 55% will be dependent upon the standard of surface preparation, 25% on the efficiency of the application of the coating, i.e., freedom from misses and pinholes, adequate film thickness at angles, edges and corners, freedom from intercoat contamination, etc., etc., and only from 20% on the coating material itself.")

B.R. Sykes (International Marine Coatings, UK) reviewed the problems and the needs of protecting static structures (e.g., oil rigs). The lifetime of oil rigs are projected to 30 years in hostile environments - and the thought of dry-docking one of these monsters is mind-boggling. Steel is the major construction material, with reinforced concrete being used more and more. For North Sea drill rigs and production platforms, the unit often is emplaced 100 miles offshore and an overhaul or complete maintenance program is impossible. Both the insides (ballast tanks) and the outsides (supports, decks, etc.) need to be protected and the best time to do this is during the initial construction phase.

The static offshore structure is exposed to three areas of attack: above the high-tide level (where build-up of salts occur and where, for concrete structures, freeze-thaw cycles can play havoc); splash zone, where the materials have a cyclic exposure to oxygen; and the submerged zone, where biofouling can be a problem and where, for concrete, the seawater can penetrate rapidly at greater depths.

Sykes reviewed some of the serious problems that occur with concrete, such as internal rusting of the reinforcing steel members, which can give rise to spalling and breakdown; sulphate attack, etc. The proper paint, however, can protect concrete structures by reducing the porosity and chemically protect against corrosion. Some details and costs were reviewed, but the overall impression was that the protection of these offshore structures represents a more complex and demanding problem than that faced by the shipowners.

Further discussions on paint formulations were presented during the two days of the conference. And some important discussions took place on cathodic protection, the techniques used and the relation between corrosion control by impressed currents and paint deterioration. This is an important and extremely complex issue, especially in light of the cargo/ballast and ballast tanks which carry a variety of liquids.

Primers, surface preparation, life-cycle management, etc. took up the rest of the Conference. The overall impression was that the paint manufacturers are developing advanced paint systems that work, but which are expensive. The ship owners and operators want the simplest type of paint which can be easily applied, in any weather, by untrained personnel, and in adverse ship conditions. Governments are manifesting control (prompted by the environmentalists) over toxicity in the yards and in harbors. This very difficult set of equations will have to be solved. This Conference, at least to this observer, was far more than a sales pitch. It was that, of course, but there were both public and private discussions and critiques which went far to aid in an understanding of the problems and, one hopes, which will lead to their solutions. (H. Herman)

PHYSICAL SCIENCES

AGARD CONFERENCE ON OPTICAL PROPAGATION THROUGH THE ATMOSPHERE

NATO's Advisory Group for Aerospace Research and Development (AGARD) held its first conference on optical atmospheric propagation at the University of Lyngby, outside of Copenhagen, Denmark from 27-31 October 1975. As with all AGARD meetings, the papers were to be made available prior to the meeting and both English and French were the official languages. The AGARD committee put together a very good conference preprint despite some uncooperative authors and bad transatlantic and transcontinental mail service. Nevertheless, with Professor K. Gudmandsen and the Lyngby University as kind hosts, an opportunity was afforded for scientists from the NATO nations working in the field of "electro-optical" (EO) atmospheric propagation to have their first chance to meet and present the results of their work.

The meeting was divided into five sessions. Session I, a long one, was devoted to attempts to characterize the atmosphere. The atmospheric molecular constituents and their effects on laser beam propagation were described; computer modeling of broadband propagation in the visible and IR ranges was also discussed, including the effects of atmospheric aerosols. Comparisons were made between theory and experiment for the two models and the agreement was found to be very good. Experiments in infrared propagation for data-gathering purposes that have been conducted in the UK, US, France and Germany were discussed by P.J. Wright (Plessey Radar, Isle of Wight), R.A. McClatchey (AFCRL, Bedford, Mass.), E. Milot (Laboratoire Central de l'Armement, Arceuil) and W. Carnuth (Institute for Atmospheric-Environmental Research, Garmisch-Partenkirchen). These experiments are in various stages of operation and agreement.

The second session was devoted to incoherent propagation through various atmospheres. The first two papers by G.N. Plass (Texas A&M Univ.) and K-N Liou (Utah Univ., Salt Lake City) were concerned with numerical methods for the calculation of radiative transfer problems in finite atmospheres.

Development of standard equations formed the starting point for the discussion of matrix-operator and Monte-Carlo techniques for computer calculation of radiance, polarization, etc.

Of particular importance to data-gathering and to the performance of EO devices in the atmosphere are remote sensing devices. A review of the various methods of probing atmospheric particulates was given by P. McNulty (Clarkson College, Potsdam, NY). The measurement program OPAQUE, a NATO experimental effort, was also described by T. Bakker (Physics Laboratorium NDRO-TNO, The Hague, The Netherlands). These measurements will be on optical parameters and meteorological characteristics of the atmosphere and will be conducted for two years throughout Western Europe. The EO sensors involved are: image-intensifiers, low-light-level television, gated viewing equipment, far infrared equipment and lasers. The aims of the program are: to establish a data base of relevant parameters for evaluating the above systems; to study correlations among the parameters; to develop theoretical and computer models; and finally to develop forecasting techniques for estimating performance of these sensors. Besides giving a fairly detailed list of things to be measured, Bakker provided a detailed description of the technical elements of the program, a list of recommended additional measurements, time schedules, and points of contact. From a programmatic point of view, this single paper was most thorough and complete and gave the meeting its "*raison de être*."

The third session of the meeting, entitled "Coherent Propagation," dealt mainly with the propagation of low-power laser beams through a turbulent atmosphere, although several papers dealing with measurements of the attenuation coefficients at several wavelengths also were included. The general hydrodynamic picture of turbulence was discussed by some speakers in a qualitative, phenomenological way that enabled one to derive some of the more important results of propagation "simply," while other speakers dealt with very specific esoteric issues. Experimental results were also presented and were compared with theory. In brief, the effect of turbulence in the atmosphere is to alter the propagation of laser beams by creating a random inhomogeneous index-of-refraction field. Inhomogeneities with sizes as large or larger than the beam cause the beam as a whole to steer away from its initially intended path or target (beam "wandering" or "steering") while inhomogeneities much smaller than the beam itself cause the individual light rays of the beam to deviate from their initially intended direction (beam "spread"). Clearly atmospheric turbulence affects the imaging process and target illumination as well. Methods of compensation designed to remove the beam wander (wavefront tilt) were discussed, and the subsequent improvement was demonstrated observationally.

H. Raidt (Research Institute for Optics, Tübingen, Germany) discussed atmospheric turbulence as a natural limit on the ability to focus laser beams. The amount of beam defocusing or spreading that occurs is somewhat dependent upon one's definition and available measurement techniques as well as on the intended mission. A long-term exposure average will combine the beam-wander effects with the beam-spread effects. A very short-time averaging may include only beam-spread effects. These phenomena are wavelength dependent, range-dependent and also dependent upon the character and strength of the turbulence.

The fourth session, "Nonlinear Propagation," devoted to the propagation of high-energy laser beams through the atmosphere, was the first of its kind for an AGARD meeting. Because most of the attendees were unfamiliar with this area of propagation research, J.N. Hayes (Naval Research Laboratory, Washington, DC) presented a survey paper designed to acquaint the audience with various types of high power propagation problems, with emphasis on the thermal-blooming phenomenon. The various aspects of thermal blooming for continuous wave, single-pulse and multiple-pulse blooming were described, while air-breakdown as an impediment to pulsed propagation was introduced. Experiment and theory were shown to be in good agreement, with no free parameters to vary. The discussion concluded with a description of the effect of atmospheric phenomena (such as turbulence and the presence of aerosols) on beam propagation and with observations on the current status of research in these areas.

A more detailed development of multiple-phase propagation was the subject of the presentation by S. Edelberg (Lincoln Laboratory, Lexington, Mass).

Empirical development, through the use of computer solutions of the basic theoretical equation of "scaling laws" to describe the propagation of multiple-pulse beams in terms of a set of fundamental dimensionless parameters was given, along with illustrative examples. The so-called scaling law was developed for a fixed waveform, and the component single pulses were chosen to avoid air breakdown. The potential for boring a hole through a fog with a high-power multiple-pulse beam was also analyzed; energy requirements for droplet evaporation were deduced and experimental observations described.

Of considerable interest was the paper by P. Ulrich (Naval Research Laboratory, Washington, DC) devoted to a survey and analysis of the many varieties of numerical methods that have been developed to calculate the properties of high-power beams as they propagate through absorbing media. The advantages and disadvantages of the different methods were discussed and comparisons made. In addition to the analysis of differing algorithms, the kinds of codes were classified according to the physical propagation problem to be solved. Methods were presented for improving any algorithm by the introduction of the so-called "adaptive coordinates systems." Comparisons between analytical results, computational results and observational data showed that our understanding of the many thermal-blooming phenomena is quite good.

Air breakdown studies were discussed by D.F. Lencioni (Lincoln Laboratory, Lexington, Mass). The presentation was devoted to a survey of results on the threshold levels for air breakdown in 10.6 μm and 1.06 μm laser beams. It was shown that the breakdown-threshold data for aerosol-free air follows the theory of Watson and Kroll quite accurately, but that the presence of dry aerosols or wet nucleated water droplets lowers the threshold. The threshold levels were shown to be generally material-dependent (with the exception of pure H_2O droplets), but were affected by pulse length and aerosol size. Experimental arrangements were described, and time-lapse photographs of the growth and evolution of the breakdown plasma were shown. Evidence that aerosol induced breakdown thresholds are proportional to λ^{-2} was shown, and data taken at other laboratories and at differing wavelengths confirm this result.

The final paper of this session by R.W. O'Neil (Lincoln Laboratory, Lexington, Mass) discussed in detail the early and recent work performed at Lincoln Laboratory on single- and multiple-pulse propagation. The experimental arrangements covering both the laser apparatus and beam diagnostics were discussed; the experimental results were compared with a computer simulation (with no free parameters) of the tests. Both the single- and multiple-pulse theory and experiments were demonstrated to be in excellent agreement. It should be noted that the single-propagation experiment was designed to avoid air breakdown, while the multiple-phase case avoided breakdown and single-pulse blooming as well.

The papers presented in Session IV and at the other sessions demonstrated that a good quantitative understanding of the important impedances offered by the atmosphere to high power propagation is available. In contrast to propagation in the real atmosphere, the theories and experiments were clearly oversimplified. Work on the more complex phenomena of turbulence, aerosols, beam jitter, multiple wavelength propagation and high power adaptive apertures has been underway, is continuing and promises to show conclusive results in the near future. It is to be hoped that at the next AGARD conference on optical propagation through the atmosphere, papers in these areas will be presented.

The fifth and final session was devoted to the limitations that propagation forces on systems, and to techniques to improve images. An extensive impressive discussion by R.P. Urtz, Jr. (Rome Air Development Center, NY) covered theoretical and experimental image improvement through "compensation" - i.e., removal of wavefront tilt. Computer simulation of image improvement by both post-detection and pre-detection systems was particularly effective. Experimental efforts in this direction are underway in several American laboratories. American research efforts at the National Oceanic and Atmospheric Administration (NOAA) on active and passive remote sensing were discussed by S.F. Clifford (NOAA, Boulder, Colorado). He pointed out that lasers were used to measure winds at remote locations using a two-ended system and a one-ended system.

Comparison of each method with results taken from more conventional measurement methods showed excellent agreement. The use of a two laser system with separately polarized beams focused at the same preselected ranges was shown to measure turbulence levels and wind levels in a one-ended system. This method allows one to obtain atmospheric wind and turbulence profiles vertically and horizontally. Extensive discussion by D.H. Hohn (Research Institute for Optics, Tübingen) of similar independent German research followed.

P.A. Stokseth (Norwegian Defence Research Est., Kjeller) discussed the bending of light rays over the surface of the ocean due to temperature gradients. The effects were dramatically illustrated by photographs taken under many and varied conditions. Data taken provided a working empirical relationship between refractive index changes with air pressure and height above the surface. The concluding papers of the meeting covered work on active and passive night vision systems, visibility measurements and helicopter effects on visibility.

The meeting was an important first for NATO-AGARD, since it brought together workers in atmospheric electro-optics for the first time within the NATO framework. The topics were, perhaps, too diverse, and consequently, the speakers and attendees were too specialized to develop an interchange that was lively and informative. Nevertheless, the EO efforts will continue to grow in all the NATO countries, and such meetings ought to be planned for the coming years. The OPAQUE program could set a model for further international cooperative research programs that could be handled nicely at meetings like these. (J.N. Hayes, NRL)

A CONFERENCE ON MAGNETIC FIELD CALCULATION

During the University Spring break, the UK Science Research Council and the Rutherford Laboratory sponsored an unusual conference at St. Catherine's College, Oxford. The Conference on the Computation of Magnetic Fields - or in computerese COMPUTMAG - the first international conference of its kind, was held primarily to bring together the two very different factions of people who are computing dynamic and static magnetic fields. These groups are the rotating-machinery engineers and the physicists interested in fusion, high-energy particles and other subjects requiring unusual magnetic fields. Because the reduction in the UK High Energy Physics budget will directly affect the Rutherford Laboratory, a thinly veiled secondary purpose of the meeting was for the Rutherford Computing Division to assess whether there is a market for their very substantial expertise in such calculations. Over 200 were present - 14 from the US and five from the USSR. Over 70 papers were contributed - only half of which were presented due to the available conference time. Judging from this popularity the meeting was warmly welcomed by the community of scientists in this area. Interestingly, there is to be yet another meeting in St. Margherita, Italy, this summer, whose intentions sound nearly the same, though I have been assured that the agenda will be quite different.

In spite of my doubts about the necessity and even the validity of a conference on a subject which might best be quietly read from a journal, I found the meeting to be quite successful. The sessions were well attended despite the very full schedule of three days plus an evening session, and the discussions were long and lively. In fact, the only complaints I heard were from some of the continental Europeans who had hoped to have a few hours to see the sights of Oxford. Since they were on the five-day "shopping tour" to London, currently the cheap way to reach England from the continent, they went home having seen Oxford only from the bus returning them to London.

Perhaps the most impressive presentations at the Conference were those which had accompanying on-line demonstrations of the capabilities of the field-calculating programs. The Imperial College group associated with Professor C.J. Carpenter has developed a program capable of handling geometries containing solid and even laminated iron which computes the two-dimensional vector potential for a steady-state field problem, and determines the eddy current losses. This program constitutes some of their preliminary work on more general three-dimensional codes to handl loss distributions and flux leakage

problems in transformers and rotating machines. Dr. D.A. Jacobs (Central Electricity Research Laboratories (CERL), Leatherhead, UK) described and illustrated the abilities of programs to compute the electromagnetic fields in the stator cores of generators. The end result of the computation is the eddy-current heating and the temperature distribution in the stator cores. The program allows the modeling of saturable and laminated iron and the complicated geometries including the core teeth and the Pistoye slots and even radial cooling ducts. Dr. M.J. Newman gave an exciting invited paper on the interactive graphics package at Rutherford and its application to magnet design. The talk was illustrated on-line at the meeting through the GEC 2050 minicomputer terminal to the Rutherford Laboratory. Many US laboratories have access to these programs through the Rutherford Laboratory Computing Division via ARPANET - which is linked to Norway by transatlantic cable, possibly soon by satellite, and into the UK by cable.

The initial invited paper was given by Professor P. Silvester (McGill University, Montreal) who reviewed the formulation of the magneto-statics problem - either by the differential equation with side conditions or the integral equation. He then discussed the various approximations and methods of discretization of the problem which are now popular and some that are not so popular. He pointed out that the usual iterative methods, though simple, were not always convergent, while the Newtonian iteration is always convergent, and quadratically at that! After briefly discussing the existing computer programs for the magnetostatics, Silvester made a forecast on the trends of the science. He sees a trend toward higher level approaches in the applied mathematics techniques and in computer science, and a trend toward more modular programming with a standardized input which will allow better intercomparison of various approaches to a particular problem and better communication with the non-specialists.

The papers presented at the Conference, clearly illustrated the trends suggested by Silvester. For example, J. Simkin (Rutherford Laboratory), the Conference organizer, presented an approach to the 2-D magnetostatics problem through the scalar potential from Green's Second Theorem. This Integral-Boundary Method (IBM) was programmed as a modular replacement for the Biot-Savart integration in the standard "GFUN3D" magnetostatics program at Rutherford. This allowed a direct comparison of the methods. The IBM is as accurate in iron as in air, which is not the case for the Biot-Savart algorithm.

Dr. H. Zijlstra (Philips, Eindhoven), in the second invited talk, discussed the mathematical modeling of magnetic materials including saturable and anisotropic ones. The remaining invited paper was given by Dr. R. Stoll (Southampton team - the influence of the upcoming Football Association (Soccer) Cup was in the air) on the numerical solution of the time-dependent magnetic fields. He contrasted the finite-difference methods (FDM) and the finite-element method (FEM) for the spatial variation; the temporal variation has always been handled by FDM. In the FEM for 2-D, an array of triangles, of variable size in principle, discretize the space domain of the problem. The field is then constrained to vary linearly over each triangle. Then one minimizes the energy functional

$$F = \iint \left[\int_0^B \nu B \, dB - AJ \right] dx\,dy$$

where J is the current density, including the eddy current contribution $-\sigma \frac{\partial A}{\partial t}$, A the vector potential and ν is the reluctivity. Stoll provided a critique of the many FDMs for solving the steady-state magnetic field problem. He favors the use of the successive overrelaxation method for the complex magnetic potential. Details may be found in R.L. Stoll's *The Analysis of Eddy Currents*, Clarendon Press, Oxford, 1974, pp. 5, 83, & 99, and *Proc. IEE (London)* 117, 1317 (1970).

Early in the Conference, Professor P.J. Hammond (Southampton team) made a very good point which is often forgotten. The point is bluntly, "Is your field calculation really needed?" He reminded us that despite the capability of today's computers to print out the field distributions (and is this output ever read?), it is often some lumped parameters such as the inductance or capacitance of the system that are required. These quantities can be computed with much less effort and often do not strongly depend on the detailed field distribution. Using FEM, Hammond illustrated his point by formulating the required functional with the correct physical meaning for his problem and solved it by the

variational technique implicit in the method.

In the computer-aided design session there were several noteworthy papers. T.J. Martin outlined the characteristics of the interactive design programs in use at Culham Laboratory and showed several examples of its use in controlled thermonuclear instrumentation such as the Tokamak, and the superconducting Levitron. J.H. McWhirter (Westinghouse Laboratories, Pittsburgh) presented a novel approach to the design of the ohmic heating coils for a Tokamak by linear programming. This, a powerful technique for engineering design, is not yet as fully appreciated as it should be. N.J. Diserens described the magnetic field calculations and stress analysis programs, "TOK" and "FINESSE", available at Rutherford Laboratory. "TOK" is especially designed for the conductor configurations involved in Tokamaks. But, perhaps the most interesting paper was given by R. Leyvraz (Brown, Boveri & Cie., Zurich, Switzerland). He described an automatic iterative generation of an optimal triangular grid for the 2-D FEM. The user needs only to specify the maximum error allowed for the energy functional F, defined above, and the program generates the grid -- a great advantage over the "manual" approach used by all previous programs.

In a special discussion on the computation of magnetic problems associated with controlled thermonuclear reactors, about a dozen useful programs available at Rutherford were mentioned. For example, "QUENCH" is a program to compute the current decay and the temperature distribution in a superconducting solenoid as it goes normal. The model is crude, but it appears to be accurate to 10%. "EDDY" is a program under development to compute eddy currents in true 3-D configurations.

This Conference, from its very nature, was replete with significant but highly technical information, much of which is reported in the 300-page booklet of the summaries of the submitted papers. A few copies may be available on request from J. Simkin at Rutherford Laboratory, Didcot, Oxon OX11 QQX England. The international committee plans a follow-up conference in about two years time. (T.A. Kitchens)

NATO CONFERENCE ON THERMAL ENERGY STORAGE

A group of 57 experts from Austria, Canada, Denmark, France, the Federal Republic of Germany, the Netherlands, the United Kingdom and the United States assembled at the invitation of the NATO Science Committee at the Turnberry Hotel in Ayrshire, Scotland early in March to deliberate on schemes of thermal energy storage (TES), to identify problems, and to propose research and development for their solutions. The hotel is located in a climatically favorable part of Scotland (to their astonishment, the attendants even found palm trees). It is distant from any major town, so there was no temptation for the attendants to stray off.

The assembled specialists were divided among four working groups: one each for high temperature TES, low temperature TES, heat transfer and thermal energy transport, and the impact of TES on energy structures. After a few introductory lectures, the groups met for intensive informal discussions, the results of which were condensed by the rapporteurs in working papers. A Conference report edited by the group of rapporteurs and the Conference chairman, Professor N. Kurti from Oxford, will be available in the near future for the benefit of all workers in the field.

The following paragraphs report on some highlights of the discussions. Nearterm high temperature storage systems (above 120°C) are expected to use pressurized water or solid beds with a pressurized gas as the working medium. Small scale stores of this kind are currently in use with containment vessels. There is great potential for large scale storage underground if a number of problems can be solved. Fluidized systems for storage have the advantage that they can use inexpensive material like sand, that energy is easily transported in quasi-liquid form, that high transfer coefficients can be obtained in heat exchangers, and that the solids can be stored compacted (unfluidized). High temperature liquids are being considered in connection with solar electric power plants.

Latent heat storage has the advantage of a large storage capacity per unit volume and that storage occurs at roughly constant temperature.

Only solid-liquid phase changes are practical because of the large density and the relatively small volume change connected with this phase transition. Contraction and expansion in melting and freezing poses difficulties together with corrosion and toxicity of some materials. Fluoride eutectics are especially promising for the temperature range between 400 and 800°C. There exists a substantial potential for chemical energy storage because of the large energy density obtainable. An example which was mentioned is the "Adam and Eve" (See ESN 29-6:264) catalytic reaction

$$CH_4 + H_2O \rightleftharpoons CO + 3H_2$$

which moves in the endothermic direction at temperatures between 850 and 1200°C and in the exothermic direction between 350 and 700°C. In such a system, storage can be combined with transmission of high grade thermal energy. The high enthalpy gas is piped to the user and the low enthalpy gas is returned. Alternatively, the methane can be burned by the user to supply additional energy and can be generated, for instance, by coal gasification. This energy transport is referred to as the "chemical heat pipe."

Small scale low temperature storage (below 120°C) for short time duration is used today with water or rocks as the storage medium. Large scale water storage in aquifers or artificial lakes is under study - especially in the Federal Republic of Germany and in France. It is proposed to store waste heat from electric power plants in the form of water at 90°C during the summer and to use it during winter to heat large communities. Heat pumps are useful to upgrade energy stored in this way. Storage of cold in winter for use in summer should also be considered. Latent heat storage systems can use ice or eutectics. Development problems like supercooling prevented a rapid introduction of eutectics as a storage medium up to now.

Many of the storage systems discussed require additional research in heat transfer. For underground storage, geological data, transport properties of soils, and *in situ* measurements are required. Computer modeling and small scale experimental work should precede the construction of demonstration plants. Equilibrium data for the water/rock system are also needed. In latent heat storage, shrinkage and expansion of the storage material, void formation, sub-cooling of the liquid, nucleation and circulation of solid particles are strongly influenced by heat transfer. Chemical energy storage poses difficult heat and mass transfer problems related to the interchange between the reacting gases and the catalyst bed. Cross-coupling of thermal and diffusive fluxes according to irreversible thermodynamics may be important.

The group concerning energy structures deliberated on the impact of energy storage on various industries, on commercial and domestic applications. Special attention was directed to district heating systems and electric utilities including economic and social implications. (E.R.G. Eckert, University of Minnesota)

*The report mentioned above is now available without charge upon request to the Scientific Affairs Division, NATO, 1110 Brussels, Belgium.

THE ATOMIC ENERGY RESEARCH ESTABLISHMENT (AERE) AT HARWELL AND MÖSSBAUER SPECTROSCOPY

As most readers of ESN must know, the support of research at AERE-Harwell is rather unusual. Harwell was established shortly after the war by Sir John Cockcroft for the purpose of pursuing a wide range of scientific research connected with nuclear energy. The laboratory grew to about 6000 employees in 1962. By 1965 however, much of the necessary knowledge on nuclear energy had been obtained and the problems of nuclear energy were now in the hands of nuclear engineers and industrial scientists in the UK. The laboratory adapted to this vanishing mandate by reorienting its research program under the guidance of Harwell's energetic and innovative director, Dr. Walter Marshall. Rather than reduce the laboratory size to one-third, (the amount of staff necessary to fulfill the on-going scientific needs for nuclear energy in the UK in the mid-sixties), Harwell decided in 1967 to attempt to sell its expertise to the academic and commercial sectors. When I visited Harwell in 1968, it was not clear how this could best be accomplished in many of the areas of research in which the Harwell staff were

involved. Even during my visit in 1971 there was some doubt whether Harwell could market all of its talent. In my recent visit, I was amazed at the improved enthusiasm and the report that over 40% of the operating revenues now come from "outside" customers. Not all is sweetness and light however. In the short term, the poor economic outlook in the UK will result in the reduction of support from industrial sources. Further, the government agencies, especially the Research Councils, have reduced their budgets for Harwell's services for this coming year. In the longer term, provided that the economic woes of the UK fade, the increased need of nuclear power will benefit Harwell.

The UK Atomic Energy Agency (UKAEA) must now feel that Harwell has been successfully shepherded through this difficult transition and has appointed Dr. Marshall as its Deputy Chairman upon the retirement of F.J. Doggert at the end of December. I understand that the Deputy Chairmanship has been strengthened and Marshall will undoubtedly play an active role at Harwell, the other UKAEA installations, as well as the new UK Department of Energy of which Marshall became the Chief Scientist in 1975.

Dr. L.E.J. Roberts, whose expertise is in the area of chemical engineering, is the new Director of Harwell. He has been involved in defining and implementing the R&D programs outside the nuclear field at Harwell and this may signal faster if not further evolution of Harwell toward a broader based energy laboratory. The non-nuclear component is now just over 25%. Roberts has also been responsible for the Marine Applied Technology and the Energy Technology Units of the Department of Energy at Harwell.

Several of the areas developed for nuclear energy purposes have immediate application in general industry. Nondestructive testing is a successful example of this and the program at Harwell has been reported recently in these pages (see F.N. Spiess, ESN 29-8:352). There are some areas, such as surface science, where Harwell has been developing expertise for which there is clear commercial interest. Perhaps the major difficulty Harwell has in marketing these two types of science is that it must do so without competing with private industry. On the other hand, if an innovation is pursued, it is pursued in collaboration with a single company, the company that Harwell feels is most capable of succeeding with the technology. Examples of the diversification of projects and the operational philosophy at Harwell are succinctly described by Marshall himself in an article "Physics Research at Harwell" in the May 1975 edition of *Physics in Technology*.

A further question is what has happened to "little science" at Harwell, especially in areas where commercial application is less evident. The professional staff has decreased by some 20% and perhaps many of the smaller groups have simply left Harwell.

In my recent trip to Harwell, I visited the small group involved in Mössbauer spectroscopy. The group has changed since the late 1960's but still has three active scientists, Drs. T.E. Cranshaw, G. Longworth and M.S. Rideout. In my previous visits they had felt their support would rely on service work. Now they receive a major portion of their support from marketing Mössbauer spectrometer systems and components. They produce cryostats, a variable-temperature cryostat insert, a velocity spectrometer and the associated electronics along with data processing and analyzing programs and provide consulting from a background of 16 years experience.

The Mössbauer group has developed two interesting γ-ray detectors. One is an end-window proportional counter having a 65% efficiency for 14.4 keV γ-rays while being more or less transparent to the much more abundant 122 keV γ-rays present in Fe^{57} Mössbauer experiments. The resolution is 2 keV at low count rates, degrading to 3 keV at count rates up to the limit of the electronics, about 10^5 γ-rays/sec. More unusual is the Harwell flowing-gas backscatter counter. This proportional counter detects internal conversion electrons emitted from the resonant abosrbed γ-rays from a sample conveniently mounted on the inside of a removable backplate of the counter itself. By choosing the proper gas, the counter can be used for either Fe^{57} or Sn^{119} resonant absorption. Since the conversion electrons escape the sample only if they are produced within 100-1000Å of the sample surface, the technique is useful for studying the physical and chemical properties of surfaces.

Cranshaw, who now finds about 50% of his time available to follow his own research interests on metals and metal compounds, has used the backscatter counter to study some technical steels. Even though these steels

show no magnetic behavior in the thin-foil transmission Mössbauer spectra, the backscatter experiments show considerable magnetic structure in the very steels that are most easily corroded. This is consistent with a martensitic surface layer and could be the same type of behavior reported by Dr. R.K. Wild of CEGB, Berkeley Laboratories, at the Solid Surfaces meeting at Southampton University (see ESN 30-5:239).

Longworth has been spending some of his independent research effort to utilize the Mössbauer Effect as a non-destructive testing technique on objects of archaeological interest. Such a study was reported by him in collaboration with Dr. S.W. Warren of the School of Archaeological Sciences, University of Bradford in *Nature* 255, 625 (1975). In this study of the Greek "Etruscan" pottery of the late sixth century B.C., found in Cerveteri, the backscatter technique was found valuable in characterizing the black pottery glaze. The iron spectra from the glazes are consistent with compounds near the magnetite end of the Fe_3O_4 - $FeAl_2O_4$ series. This work should provide an earmark to classify potsherds of Greek black as well as help understand the firing technology of that period.

It appears that, at least for the small group involved with Mössbauer spectroscopy, the Harwell experiment of self-support has been successful for the last few years. It is not apparent that it can remain successful with a known 30% cut in the Scientific Research Council's budget for services to University projects next year and the vagaries of the marketplace in such a poor economic climate.

Even without disturbing outside economic influences there is the fundamental question of how much internal funding is necessary to maintain an equilibrium of new science and technological applications stemming from Harwell. Given the high technology character of Harwell's work, was even the old target of 33% of the total funding from outside sources too high and was Harwell just selling the products of 15 years of previous work without rejuvenation? Judging from the three areas mentioned in this article -- Non-destructive testing, Surface Science, and Mössbauer Spectroscopy -- the overall answer is "No", but the equilibrium implies some personnel turnover. Now one hears the figure of 50% outside support at Harwell and personnel turnover is slow. Perhaps this is the equilibrium point. (T.A. Kitchens)

THEORETICAL MODELS AND METHODS IN SURFACE SCIENCE

The science of solid surfaces has been making large strides in the recent past. This advance has been made possible by improved instrumentation and vacuum techniques. As mentioned in a recent article (ESN 30-5:239) the experimental surface scientists have already developed some 60 techniques, for analyzing the physical and chemical properties of surface layers, but most are only vaguely understood in detail. With suitable calibration, however, many of these methods can be used for quantitative chemical analysis. Even with this substantial activity, most investigations have been confined to the metallic substrates such as Cu, Au, Pt, Ir, and Ni. The latter three, while not simple, are very important technologically. The theoretical work required to obtain a proper understanding of surface phenomena has been lagging, hampered mostly by the lack of the 3-D periodic symmetries which have been so very useful in understanding bulk solids. Nevertheless, with the increasing plethora of reproducible experimental results and the obvious practical importance of surface effects such as catalysis, an ever larger number of industrial, governmental, and academic theoreticians are turning their attention to these problems.

In order to assess the present theoretical position and to plan an intensive summer workshop at Orsay, Professors C. Moser (Orsay) and M. Simonetta (University of Milan) held a Colloquium entitled "Models and Numerical Methods Applied to the Study of Surface and Adsorbates on Surfaces." The four-day Colloquium began on 20 April on the Place Jussieu campus of the University of Paris which contains Paris VI (which was on Spring vacation) superimposed on by the more radical Paris VII (which was on Spring strike). About a dozen and a half of the international leaders in the field, both chemists and physicists, were brought to Paris by the Centre Européen de Calcul Atomique et Moleculaire (CECAM) a part of the Centre National de la Recherché Scientifique, to discuss their latest work. I will recount some of the talks here.

The scene was set by a review of the present position of structural determinations of surfaces and adsorbates by Professor G. Somorjai (University

of California, Berkeley). He spoke on his recent Low Energy Electron Diffraction (LEED), photoemission spectroscopy, and ion-beam spectroscopy studies on such systems as acetylene and benzene on Pt or Ir, designed to better understand surface chemical reactions and surface mobility. He also reported on his work on the C-C and C-H bond-breaking ability of surface steps and remarked that the carbonaceous film, which is nearly impossible to remove from surfaces with a high density of steps, appears to be very active in the bond-breaking. He pointed out that at the present level of development, LEED is not capable of determining the exact structure or of studying the order transition of large molecules, such as benezene on Pt or Ir. He made the salient comment that surface passification was at least as important as heterogeneous catalysis and should receive more attention. Somorjai was impressed with two new instrumental capabilities; one which allows materials prepared at high pressure and high temperatures to be studied *in situ* by electron spectroscopy, and the other, which allows a study of electron beam damage and recombination of organic layers of low electron intensities by using image intensification. On the theoretical side, he felt that more attention should be directed at localized bonding and at realistically rough surfaces. He also felt that some emphasis should be on calculations of charge and mass and other transport properties on the surface.

In the ensuing discussion, most of the audience, in which the physicists outnumbered the chemists, felt that Somorjai was trying to run before walking. However, since catalysis is such an important phenomenon, there may well be some skipping before walking well.

Only a couple of the presentations at this meeting attempted an approach close to Somorjai's outline. The most informative, given by Professor R. Mason (Sussex University, Brighton), addressed the questions of the electron structure of clean surfaces and the integrity of ligands as they arrive at the surface. He reviewed the integrity question from an molecular orbital point-of-view for CO and unsaturated hydrocarbons, and went on to consider surface steps, corners and terraces on the surface. He argued that the observations are not consistent with models which account only for the effects of such structures on the electron density such as L. Falicov's; charge build-up and field gradients and a two-site hypothesis must also be incorporated. Mason also made an important, though obvious, point that surface scientists may never be able to work in an environment equivalent to that used in commercial catalysis. If adsorbate gases are to be used near atmospheric pressure, purities greater than one part in 10^{12} are required before one is sure a monolayer of impurities is not being studied.

Three talks were given on the theoretical interpretation of photoemission studies. Dr. J. Pendry (SRC Laboratory, Daresbury) presented a critique of the established elements of the theory of photoemission and, for the first time, presented a calculation including all of these elements in a formulation which uses the same multiple scattering programs as the LEED calculations. The calculation accounts for the mean-free-path effects in the final states but neglects non-refractive processes, phonon and other many-body scattering effects. The calculation showed that for angularly resolved photoemission spectra, the spectra were not very sensitive to surface states and most peaks were due to the selection rules rather than the density of states. The agreement with the observations on Cu were qualitatively good, and Pendry claims the difficulties are in the band calculations rather than this photoemission theory. This work will soon appear in *Surface Science*. D.W. Jepson (IBM Yorktown Heights) presented his calculation for angularly resolved photoemission for Mo from an older form of the theory. Mo is quite relativistic, and Jepson felt that the major discrepancies in the theory and experiment were due to the fact that the band structure used was calculated non-relativistically.

There were several presentations on semiconductor surfaces. Dr. J.A. Appelbaum (Bell Telephone Laboratories, Murray Hill) presented his work on semiconductor surfaces, both clean and with ordered overlayers. The calculations are self-consistent and utilize the well-documented pseudo-potential for Si. In this work he has used the Wigner local density approximation to account for exchange and correlation. He is currently considering hydrogen chemisorption, the Si (110) surface where each Si atom has two broken bonds and the reconstruction of the (110) surface of the III-V semiconductors

Professor E. Tosatti (University of Rome) spoke on semiconductor and transition-metal surface reconstruction in terms of atomic orbitals and on the possible influence of charge density waves. Professor V. Bortolani (University of Modena) talked of his Slater-Koster approach to semiconductor surfaces. These calculations for GaAs were in good agreement with older experimental data but not with the more recent results. He argued that self-consistency is needed. Dr. A. Lubinsky presented the calculations done at Xerox Laboratories, Rochester, for elastic LEED on III-V and II-VI semiconducting compounds by the Linear Combination of Atomic Orbitals (LCAO) approach. These calculations and elastic LEED data suggest that for the GaAs (110) surface, reconstruction implies that the Ga atoms rotate slightly out of the surface and are characteristic of the covalent type reconstruction. For the ZnO (1010) surface, it appears that the O moves out of the surface about 0.1 Å while the Zn moves into the surface about 0.3 Å and is characteristic of ionic type reconstruction. A couple of participants felt that angularly resolved photoemission may prove to be a more sensitive probe of these phenomena.

Dr. R. Haydock (Cambridge University) and Dr. J. Appel (University of Hamburg) spoke on approximate calculations of the electronic states for transition metal surfaces. Haydock discussed an approach using local orbitals and attempted to factor the problem to maintain some interpretive ability rather than putting everything in and turning the mathematical crank. Appel has roughly the same philosophy of factoring the problems but with an eye to detect which elements of the calculation may be dropped.

Several groups presented their work on chemisorption by calculations on small clusters of atoms. The fond hope is that one can consider the problem of chemisorption by chemisorbing an atom or molecule to the cluster, a tractable calculation if the cluster and molecule are small enough, and then embedding the cluster into the surface of the bulk. Presently no one knows how to do the second calculation, but the argument is that if the cluster is large enough, the embedding will not perturb the energy of the bulk or the cluster. Since there is evidence that the atomic wave functions are still not those of bulk atoms more than four layers into the surface, one can estimate that clusters of about 100 atoms would be required. Present computer limitations require that calculations be on clusters of less than twenty atoms.

Professor J. Connolly (University of Florida) reviewed his work on small metallic clusters and chemisorption. Even for clusters of 13 Ni atoms he pointed out that going beyond a Hartree-Fock calculation is at the present time inconceivable and that a local density approximation is the method of choice. He then criticized the use of "muffin-tin" potentials for surfaces and small clusters - but proceeded to use them anyway. He asserted that the bond distance for chemisorbed atoms is about correct and that the binding energy is within 20%. He stated that the consensus of the Florida group and the IBM-San Jose group, who use an independent method, is that the cluster approach does not predict an accurate density of states but that the chemisorption properties are reasonably accurate.

Dr. J.F. Harris (KFA, Jülich) also spoke on chemisorption on small clusters and was very enthusiastic about a new approach, developed by O.K. Anderson, involving Linear combinations of orthogonal Muffin-Tin Orbitals (LMTO). He has no experience yet with the calculation but has started on some simple systems like Al_5O and Al_5Na. The computer programs appear to require little time, so this method may prove to be very useful.

The summary discussion session was not relaxing due to the impending student demonstration at Place Jussieu on Friday afternoon. Nevertheless, various suggestions were made about the summer workshop. It was felt that it is important to have both the chemical and the physical viewpoints presented by the participants of which about a dozen from outside the Paris area will be invited. Oxygen and carbon on transition-metal surfaces and surface reconstruction were suggested as worthwhile problems. More significant calculations certainly could be attempted on the IBM 370/168-168 system available to the workshop but many of the participants felt that the theoretical framework is too nebulous to warrant the effort. The last say on the summer's program will be by CECAM, who has to see how these ideas fit with those for the other two summer workshops at Orsay, one on

electron-phonon interactions near critical points and the other on reactive scattering. Because of the latter subject, this workshop will probably concentrate its efforts on the static surface properties. It was an interesting meeting, and especially noticeable was the fact that, with the possible exception of Anderson's LTMO method mentioned by Harris, every approach discussed has had some connection with groups in North America.
(T.A. Kitchens)

SPACE SCIENCES

ASTRONOMICAL POT POURRI

Well over 90% of the meetings of the British Royal Astronomical Society (RAS) are held in London. Occasionally, however, a meeting is scheduled at another location so that attendees can also visit a particular institution's facilities and so that more students and others from that region of the country can attend the meeting. The most recent example of this was the 8-10 April meeting of the RAS which was held at the University of Manchester. Combined with the meeting was an extensive tour of the neighboring Jodrell Bank radioastronomy facilities.

The meeting itself was very well attended with over a hundred people present at all the sessions. Included in the subjects covered were x-ray astronomy, gravitational astrophysics, optical astronomy with the Science Research Council (SRC) Schmidt telescope, and extragalactic radioastronomy. A wealth of both detailed and summary information was presented. The remainder of this brief note will be devoted to those items which, in my opinion, would be of most general interest to space researchers.

First of all, the usefulness of the Mt. Palomar sky survey for a variety of purposes ranging from basic research to guidance problems is widely recognized. This survey was taken with a 48-inch Schmidt telescope in the 1950's. Because of the northern hemispheric location of Mt. Palomar, however, the survey in general covered the sky only down to -30° galactic latitude. It was to complete this sky survey by conducting similar observations of the southern sky that the SRC Schmidt was built and then placed in operation in Australia. While the telescope is similar to the Mt. Palomar Schmidt, the newer Kodak 3AJ emulsion has allowed the southern sky survey to reach objects 1.5-2 magnitudes fainter. So far, about one-third of the southern sky has been photographed in the blue with survey quality and another one-third has been photographed with very good but not final quality. In his talk, Dr. R. Cannon [Royal Observatory, Edinburgh (ROE)] said that all these results are available for users at the ROE. Publication of this southern sky survey is scheduled to start this August with an initial printing of 125 copies. Of these, about 100 already have been ordered, so those needing copies should act promptly.

On an entirely different subject, F. R. Stephenson (Newcastle-upon-Tyne) reported on his detailed review of about 2,000 years of records from China, Japan, and Korea related to the occurence of supernovae. These included observations of the date and position in the sky of a wide range of astronomical objects including comets. He has identified four supernovae events with certainty and another four as "probable." As a subsidiary point, no records were found over this whole period which could be interpreted as observations of "unidentified flying objects."

The report of x-ray astronomy observations made with the UK Ariel V occupied a major portion of the meeting. The observing program of this satellite recently has been focused on two prime objectives. One has been to study the approximately 10-second-long x-ray bursts discovered by the Netherlands Astronomical Satellite and subsequently observed by the US SAS-C and Vela satellites. To do this the University of Birmingham x-ray spectrometer experiment has been operated in its time resolution mode (32 second time resolution with 34° diameter field of view). During March of this year a sequence of about 350 of these bursts was observed with a burst separation of about 1.4 hours and a 0.5% jitter. The length of this burst sequence is over an order of magnitude longer than any reported previously. Observing programs in a mapping mode are now in process to obtain a good position for what appears to be still another new type of x-ray source.

The other objective of the

Ariel V observing program has been to conduct a full-sky survey of x-ray sources with a uniform level of source detectability. The source strength limit of this survey will be slightly lower than that of the US Uhuru satellite survey which covered 85% of the sky. In addition to source positions and intensities, the survey when published will include information on the sources' spectral index and variability. Positional accuracies of about one arc minute are planned for all but the fainter sources. For the latter, less than 20 Uhuru counts, the positional accuracies will be about ten arc minutes.

Finally, Prof. Martin Rees (Cambridge) presented the George Darwin Lecture to the meeting. He was introduced by Sir Bernard Lovell to an audience of over 200 including the Mayor of Manchester. The lecture was primarily of a review nature in which Rees noted that the past decade has really been a golden one for astronomy. This was largely made possible by the opening of the astronomically useful spectrum into the radio, infrared, x-ray, and gamma ray regions. Examples of the many new types of energetic phenomena that have been studied during this period include pulsars, radio galaxies, Seyfert galaxies, and black holes. He noted that quasars wouldn't have seemed nearly so strange if they had been discovered after these other phenomena, since it now looks like they're just extreme examples of such energetic processes and that their observed red shifts are real. This would, of course, make them some of the oldest objects to be observed in the universe. It was Rees' opinion that the study of the objects formed early in the creation of the universe could be one of the most productive areas of future astronomical research and one for which space-based systems, such as the planned US Space Telescope, will be needed. In noting that political-technical approvals are required for such major projects, he cautioned against the formulation of new programs solely by use of the scientific method, wherein a problem is defined and then the steps needed to solve the particular problem determined. It was his point that one should always remember that it is usually the speculative issues that can potentially advance our understanding the furthest and that these invariably require that risks be taken. This is especially true since risks are usually the anathema of the political-technical approval process. (L. H. Meredith)

KIRUNA GEOPHYSICAL INSTITUTE

The Swedish Kiruna Geophysical Institute, KGI, started in 1957 as the Kiruna Geophysical Observatory. Since that time, however, the Lycksele Ionospheric Observatory as well as the groups working in upper atmospheric geophysical research at both the universities of Umea and Uppsala, have been made a part of the KGI. As a result, it now has the responsibility for all Swedish ground-based geophysical observations. Of the total KGI staff of about 70, 40 are at the Institute itself which is located on a large wooded tract approximately 5 km east of Kiruna.

During my recent visit to the Institute, Dr. Bengt Hultqvist, the Director, discussed their program and showed me their facilities. Their major effort is oriented toward those ground-based studies which make use of the northern location of the Institute. Thus they operate or provide facilities for all sky cameras, filter photometers and spectrographs, cosmic ray monitors, seismic detectors, VLF receivers, infrasound receivers, pulsation recorders, 3-component magnetometers, etc. While most of these instruments are relatively standard, a few points deserve special note. One of these points is that the Institute will house the administrative headquarters for the new European Incoherent Scatter Facility (ESN 29-11). This will involve providing facilities for the computer which will generate the observing program, for the headquarters people, and for the scientists who come to use the facility. In addition, KGI will have the responsibility for implementing the Swedish EISCAT contribution. In this role it will provide the site for one of the receiving stations and the receivers for all three of the receiving stations. KGI will also redirect its VLF interferometric program to one of providing time standards and communication for the EISCAT system. With an EISCAT commitment for a three-year development period followed by at least ten years of operation, this facility will be providing a major focus for the

KGI activities for the foreseeable future.

Another point deserving special note is the ultrasound program. This program was started at KGI by Dr. L. Liszka to study the inaudible sound, 0.1 to 10 Hz, generated by the motions of auroral electrojets. By using stations consisting of three microphones and measuring phase differences with a narrow-band system centered at 2 Hz, the arrival directions of such auroral infrasound were measured. Perhaps even more interesting, however, was the fact that this station detected signals from a variety of other sources. By using four such stations in northern Sweden it was possible by triangulation to locate the origins of this sound. The sources found included such relatively distant ones as individual North Sea oil drilling activities and a USSR nuclear test. At more moderate distances were industrial activities such as hydroelectric power plants and cellulose factories, while at distances less than about 50 km helicopters could be detected. This work is now being picked up by other Swedish organizations and is being directed toward the study of both the health hazard which exposure to high levels of infrasound may produce, and the applicability of infrasound to a number of problems such as monitoring the efficiency of individual hydroelectric power stations.

Closely related to the KGI ground-based observation program is their program to make *in situ* measurements of medium energy magnetospheric particles. For example, they will be providing for the ESA GOES satellite a set of ten electrostatic analyzers with channeltrons to measure the flux, spectra, and pitch angle distributions of 0.2 to 20 Kev electrons and protons. This satellite is planned for launch into a geosynchronous orbit next year. For over half its active life it will be positioned on essentially the same earth's magnetic field line as KGI. This will make possible the correlation of the particle fluxes observed on the satellite with the auroral zone effects observed with the ground instrumentation at KGI. Their measurements on this satellite are a natural follow-on to the similar measurements conducted on the ESA satellites ESRO 1A and B in the late 1960's and ESRO-IV in the early 1970's. All three of these satellites, however, were in relatively low altitude polar orbits and so sequentially sampled all latitudes. This is in contrast to the GOES satellite, which will provide continuous observations at essentially one latitude.

Finally, the group is conducting an active sounding-rocket program to measure the energetic particles precipitating into the atmosphere in individual auroral events. The measuring systems used on these rockets are almost identical to those used on the satellites. Since these rockets are launched from the ESRANGE launch site which is only about 30 km away from KGI, their ground observing systems also are used to define the auroral conditions at the time of each of these launches. In order to support the International Magnetospheric Study program, their current launch rate of about five such experiments per year is approximately twice normal. (L. H. Meredith)

NORWEGIAN SPACE ACTIVITIES

Although the Norwegian space program is relatively small, about $3 M per year, it is well organized, active, and growing. It is not the intent of this note to review all of the individual efforts in this program, but rather to try to provide some understanding both of the program's background and the directions in which it seems to be moving.

First of all, since the late 1800's, Norwegian scientists have been active leaders in efforts to understand the aurora. Included have been such distinguished researchers as Birkeland, Stoermer, Vegard, and Harang. This tradition is being continued at a number of institutes and universities in Norway. The primary group now making ground-based auroral zone studies is at the Auroral Observatory of the University of Tromsø. In discussing their program with Dr. E. Leer it was clear that they currently are conducting an extensive, but more or less routine, program of ground-based monitoring that includes magnetometers, photometers, riometers, all-sky cameras, etc. They recently have, however, placed in operation a pulsed ionospheric-scatter facility. This facility operates at 2.25 MHz and is obtaining returns from altitudes of about 40 to 100 km. As such, it will

complement the measurements that will be possible at altitudes above 90 km with the EISCAT (ionospheric scatter facility) (ESN 29-11:493). This is especially true since it is located at the identical site (about 20 km east of Tromsø) as that planned for the EISCAT transmitters. In this regard, the Observatory will have the responsibility for both maintaining and operating the EISCAT transmitting and receiving capabilities in Norway, and it is expected that its research program will continue to shift toward the analysis of such sounding data.

Closely associated with the ground-based auroral research program is the auroral sounding rocket program. While several different groups participate, the program of the Norwegian Institute of Cosmic Physics in Oslo is representative. This Institute is headed by Dr. Alv Egeland, who described his own program and showed me Norway's Tromsø tracking station and Andoya rocket-launching range. The Andoya range has the capability of launching almost any solid-fueled rocket as well as the necessary facilities to support the experimenters. In addition to its auroral zone location, the range has the distinct advantage of a nearly unrestricted impact area in the Norwegian Sea. While it has been used by Norwegian research groups, it also has been used by groups from Germany, Switzerland, England, Sweden, US, Austria, and the European Space Agency (ESA). Egeland's own program, however, has been primarily directed toward studying the height distribution of proton and other auroras by flying Hα, Hβ, and other photometers and toward studying small-scale auroral irregularities by measuring ac electric fields in the range 100 Hz to 5 MHz.

In addition to its scientific accomplishments, the auroral research program has provided much of the impetus that led to the establishment of the Tromsø Satellite Telemetry Station. This station has been used for a number of ESA, Canadian, and US satellites. In addition to its VHF capability, it has added an L-band system so it can receive the Very High Resolution Radiometer, VHRR, data from the US Nimbus satellite. Planning is now in process to determine whether an S-band capability should be added so that US Landsat satellite data can be received.

Both the Tromsø station and the sounding rocket program have been technology drivers for Norwegian industry. For example, the first Norwegian computer was built for this tracking station, and similar computers will be used in the future for EISCAT. Also, gimbals and telemetry encoders developed in the sounding rocket program are finding application both in industry and military programs.

At least equally important, however, has been the background of experience with space systems that these auroral programs have provided. This experience is being used now to expand the application of the space systems. As one example, Mr. E. Enderud of the Norwegian Council for Scientific and Industrial Researches (NTNF) Space Activity Division described their program to develop both unmanned and shipboard satellite interrogated data platforms. As a part of this program, buoys have been built which can operate either on an ice floe or in the open water for six months and be tracked by the US Nimbus-F satellite. Positional accuracies of about 200 m have been obtained with this system. Last year, three such buoys were used by the Norwegian Polar Research Institute to track the motion of ice floes between Greenland and Norway. All three buoys were recovered. This year the program is being expanded to include six such buoys in the Arctic as well as six in the Antarctic.

In yet another area, the Norwegian Water Resources and Electricity Board is one of the major groups actively studying the applicability of images from the US Landsat satellite. This governmental agency is responsible for producing about a third of all the electric power produced in Norway (100% of which is hydroelectric). In discussing their research program with the Chief Hydrologist, Mr. J. Otnes, it appears that such satellite imagery will be useful in helping to increase the efficiency of their power system. Primary contributions are expected in areas such as monitoring glacial-stream sediment loads prior to siting new power stations; determining, each year, whether the masses of individual glaciers have expanded or contracted; and in determining the cumulative water discharge in basins by monitoring snow-line changes. The work is taking on increasing importance as the power demand rises and the limit of this resource is approached (which, according to projections, will be within a decade if significant improvements in efficiency are not made).

As a last point, Norway is internationally linked by a microwave system capable of handling a single TV channel. While this minimizes family arguments as to which channel to watch, the program selection is also minimal. As a result, a second channel will very probably be added within a decade. Since cost studies have indicated that a satellite TV-relay system would cost only half as much as upgrading their present microwave relay system, it seems very likely that a satellite system to serve all Scandinavia will be built.

Finally, the Norwegian program has been organized and pushed for the last eight years by Mr. K. Melby who headed the NTNF Space Activity Division. He kindly arranged my visits and was most helpful in describing many other areas in their program. It is with sorrow that I must report that he passed away in early May of lung problems while attempting to reach a European meeting on auroral zone research, near Munich. (L. H. Meredith)

PROJECT PORCUPINE

Project Porcupine is the largest single sounding rocket project ever mounted to study auroral processes. The project itself, of which only the major points will be touched here, is managed by the Max Planck-Institute for Extraterrestrial Physics, with Dr. G. Haerendel as the Project Scientist. Its major objectives are two-fold. First, it will attempt to obtain as complete a measurement as possible of the plasma parameters within and above auroral arcs. Second, it will use space as a laboratory for studying plasma processes.

To accomplish these objectives, each sounding rocket will carry a complement of a dozen different experiments. While many are provided by cooperating institutions, the primary responsibility for six of the experiments is German, two is French, two is US, one is USSR, and one is ESA. The measurements to be made can be summarized briefly as being of the electric fields with frequencies from 0 to 20 KHz using two pairs of booms, plasma density fluctuations with a boom mounted spherical sensor, vector magnetic fields with a boom mounted magnetometer, AC magnetic fields from 10 to 500 Hz with a search coil, electron fluxes from 100 ev to 200 Kev, and of the proton fluxes from 100 ev to two Mev. In addition, the electron temperature and density will be measured both with a hybrid resonance frequency measuring system that's on a boom and with retarding potential systems that are mounted on a boom as well as directly on the rocket. These experiments provide what might be called the basic set of plasma-parameter monitoring experiments. Altogether, they entail the deployment of eight booms. It is this large number of booms, of course, which was the origin of the project name of Porcupine.

In addition to this basic set of experiments, the payload also includes a number of more specialized experiments. One of these entails the deployment of another four booms spaced along the length of the payload to try and measure the electron flow velocity from which the field-aligned electric current can be derived. The method of measurement is to try and determine the frequency shift of the lower oblique resonance of the ionospheric plasma. Since the shift of this resonance frequency depends on the magnitude of the plasma velocity relative to the propagation direction, signals in the 0.1 to 1.5 MHz band will be transmitted and received with various boom combinations. For example, signals will be transmitted from the top two and received by the bottom two booms, transmitted from the bottom two and received by the top two booms, etc. Calculations have shown that this system should be capable of detecting the lower oblique resonance shifts and making the desired electric current measurement. This will be the first attempt to perform such an experiment.

While all the experiments described so far stay attached to the rocket, the payload also includes four ejectable canisters. Each weighs about 20 kg and one carries experiments to measure the electric field, magnetic field, electron temperature and density, 1 to 500 ev electron flux, and the 500 ev to 40 Kev electron and ion fluxes. By correlating these measurements with those made on the rocket, it should be possible to separate spatial and temporal effects.

Another canister contains a cesium plasma evaporator. This will first be activated for ten seconds when the canister is between 10 to 60 meters from the rocket. It will then be turned on twice again for ten-seconds each

when the canister is at about 300 and 600 meters from the rocket. The expansion of this cesium beam in the magnetospheric medium will be studied both by the instruments on the rocket and by ground observations.

The last two canisters will contain barium that will be ejected near the rocket peak altitude of about 460 km but separated in time by two minutes. The barium will be ionized by sunlight and the observation of the cloud's expansion will allow studies of the magnetospheric electric fields as a function of altitude, magnetic field line distortions, and perturbations of the ambient plasma caused by the cloud.

Finally, an extensive array of ground based observations has been set up to observe both the auroral conditions at the time of launch and the cesium and barium cloud emissions. This includes USSR and US jet airplanes with TV systems, ground based TV systems in Sweden, Norway, and the USSR, a special four station VLF network, and a magnetometer network with stations at about every one degree of latitude and longitude over northern Scandanavia. In addition, correlative observations will be made on the US ATS-6 satellite which is located over the equator on approximately the magnetic field line going to ESRANGE, the Swedish rocket range which is near Kiruna and in the auroral zone.

The sounding rocket to be used to carry the experiments into the magnetosphere is the Aries. This is a Minuteman second stage to which a special control system has been added. It will be launched from ESRANGE. Two flights in the spring of 1976 and two in the fall of 1977 were planned. For these Aries launchings, a special launch complex with a roll-away building has been built. Also, the high Porcupine data rates necessitated the addition to ESRANGE of an S-band telementry station.

From this very cursory outline of the Porcupine Project, it should be apparent that it represents a major undertaking. In fact, its funding from Germany is about $4.5M but this, in general, doesn't include the money spent by many of the participating institutes. When these costs, as well as the costs in the cooperating countries are included, the total cost is probably double this amount, making this sounding rocket project comparable to that of a satellite.

The first Porcupine launch attempt, which I was fortunate to be able to observe, was on March 17, 1976. Everything was ready but the auroral activity was very minimal over ESRANGE. Attempts were made to launch for the next 13 nights with continuing lack of cooperation from the aurora. On March 31, however, a large stable arc was present over ESRANGE and the first Porcupine was launched. The Aries blew up two seconds short of its nominal burn-out time and no Porcupine experiment data were received. Three major failure reviews have been initiated and, needless to say, this is a sticky situation. It is expected that the fault will be found so that the remaining three flights can be launched in the fall of 1977. (L. H. Meredith)

NEWS & NOTES

Britain's well-known and excellent scientific register, *Scientific Research in British Universities and Colleges*, ceased publication with the current issue, 1974-75. The British Library Research and Development Department, which recently took over its publication, decided on the cancellation as the publication was losing money. A project at Southampton University, funded by the British Library R/D Department, is currently investigating the most favorable format for a national registry of scientific research to replace *Scientific Research* - one that will be self-supporting.

PERSONAL

Four new members have been appointed to the governing board of the Advisory Board for the Research Councils: Sir K. Berrill, Director General, Central Policy Review Staff, Cabinet Office; Professor C.C. Booth, Professor of Medicine, Royal Hammersmith Hospital; Sir Alan Cottrell, Master of Jesus College, Cambridge; and Mrs. J.E. Floud, Principal, Newnham College, Cambridge.

Mr. T.M.F. Smith, Senior Lecturer in Statistics, University of Southampton, has been appointed to the Chair of Statistics at that University.

The research library at Liverpool University's Department of Applied Mathematics and Theoretical Physics was recently named the Frölich Library in honor of Emeritus Professor Herbert Frölich, who retired in 1973 after holding the Chair of Theoretical Physics for 25 years.

Professor P. Armitage, Professor of Medical Statistics, London School of Hygiene and Tropical Medicine, has been appointed Professor of Biomathematics at the University of Oxford.

Dr. P. Ayscough, Reader in Physical Chemistry, has been appointed to a personal professorship at the University of Leeds.

Dr. G.R. Bacon, Reader in Organic Chemistry, Queen's University, Belfast, has been appointed to a personal chair at the University.

Professor Anita Bailey, who has been working at one of the Research Institutes of the Fraunhofer Gesellschaft in West Germany, has joined the Department of Chemical Engineering and Chemical Technology at Imperial College to take up a newly established Chair of Interface Science endowed by Kodak Ltd. She is the fourth woman professor in the College's history.

Professor E.A. Barnard, formerly Professor of Biochemistry at the State University of New York at Buffalo, has taken up his appointment to the Rank Chair of Physiological Biochemistry in the Biochemistry Department at Imperial College.

Dr. J.A. Betts, Reader in Electronics, University of Southampton, has been appointed to the Chair of Communications in the Department of Electronics in the University.

Dr. K.G. Binmore, Reader in Mathematics, London School of Economics and Political Science, has been appointed to the Chair of Mathematics at the LSE.

Professor R. Bonnett, Professor of Organic Chemistry at Queen Mary College, London has been appointed to the Chair of Organic Chemistry at the College.

Dr. H. Burkhardt, Senior Lecturer in Mathematical Physics, University of Birmingham, has been appointed to the Chair of Mathematical Education, University of Nottingham.

Dr. J. Delaney, Senior Lecturer in the Department of Biology, University of Southampton, has been appointed to the Chair of Environmental Sciences, University of Bradford.

Professor S.W.E. Earles, Professor of Mechanical Engineering, Queen Mary College, University of London, has been appointed to the Chair of Mechanical Engineering at King's College, London.

Dr. R.J. Ellis, Reader in the Department of Biological Sciences, Warwick University, has been promoted to a personal chair in biological sciences from October.

Dr. J.B. Goodenough, leader of the Electronics Materials Group, Lincoln Laboratory, Massachusetts Institute of Technology, has been appointed to the Professorship of Inorganic Chemistry at the University of Oxford.

Dr. Frank Hartley, Dean of London University's School of Pharmacy, was elected Vice-Chancellor of London University, after serving three years as Deputy Vice-Chancellor. He succeeds Professor Sir Cyril Philips, who announced his intention to resign in December. Hartley takes up his position immediately and holds it until the end of the next academic year, 1976-77.

Dr. F.W. Hemming, Reader in Biochemistry, University of Liverpool, has been appointed to the second Chair of Biochemistry in the Medical School, University of Nottingham.

Dr. M.W. Holdgate, Director of the Natural Environment Research Council's Institute of Terrestrial Ecology, has been appointed Director-General of Research at the Department of Environment.

Dr. J.H. Humphrey, Deputy Director of the National Institute of Medical Research, has been appointed to the Chair of Immunology at the Royal Postgraduate Medical School, London.

Dr. J.C. Jackson, Senior Lecturer in South East Asian Geography, University of Hull, has been appointed Professor of Modern Asian Studies, Griffith University, Brisbane, Australia.

Professor John Kingsley Luffingham, Senior Lecturer in Orthodontics at the Dental School, University of Glasgow, has been appointed to the Chair of Orthodontics at the University.

Professor Lionel March, formerly Professor of Systems/Design, University of Waterloo, Ontario and now Lecturer at the University of Cambridge, has been appointed Professor of Design at the Open University.

Professor Paul Matthews, Head of the Department of Physics, Imperial College, has been appointed Vice-Chancellor of the University of Bath from 1 October 1976. Professor Dan Bradley will succeed Matthews as Head of the Department of Physics for a five-year period beginning 1 September.

Mr. M.A. Moore, Lecturer in Theoretical Physics, University of Sussex, has been appointed to the Chair of Theoretical Physics, University of Manchester.

Dr. N.E. Simons, Reader in the Department of Civil Engineering, University of Surrey, has been appointed to the new Chair of Geotechnical Engineering at the University.

Dr. I.B. Thompson, Reader in Geography, University of Southampton, has been appointed to the Chair of Geography, University of Glasgow.

Dr. A.F.G. Wyatt, at present Senior Lecturer in Physics, University of Nottingham, has been appointed Professor of Physics, University of Exeter.

A QUICKIE FROM VICKI:

In ESN 30-3 of March this year the Office kindly announced that I was on sick leave because of major surgery. I'm pleased to report that I'm now back in harness--at least part-time. I would like to take this means of thanking the many readers, among whom are lots of old friends, who sent me lovely cards and notes. It was most heartwarming, and I'm sure they did much to speed my recovery. Thanks again to all - It's good to be back! (Victoria S. Hewitson)

ONRL REPORT ABSTRACTS

R-3-76 AQUEOUS ARTIFACTS: THE RIDDLE OF BOUND WATER, by J.B. Bateman

This paper, intended for the general reader, first discusses early ideas about water binding in biological systems. More recent work is presented in the form of a report and commentary on lectures given during a Royal Society discussion meeting, together with occasional references to other literature and to papers given at a somewhat similar symposium in Roscoff. The conclusion to be drawn is probably that although the acceptable definition of bound water is in doubt and the interpretation of experimental data frequently ambiguous, water binding to biological macromolecules to the extent of about 0.3 - 0.5 g. water/g. dry weight is fairly general. Further, there is evidence that the rates of many biological reactions may be controlled both by direct consumptive participation and by catalytic shifts of water molecules attached in and around receptor sites. A current controversy concerning the role of "structured" water in active transport recalls similar disputes among the earlier proponents and opponents of water binding, dating probably from Overton's introduction of the idea in 1902. Plus ça change.....

R-4-76 "SUPERCONDUCTIVITY: A CHANGING R & D SCENE IN GERMANY" , by R.A. Hein, Naval Research Laboratory, Washington, DC

Most of the German research and development associated with superconductivity is centered at the Institut für Experimental Kernphysiks at the Kernforschungszentrum in Karlsruhe and at Siemens AG Research Laboratories in Erlangen with some basic physics and materials studies at various universities and institutes. This report discusses the present status of research and development in superconductivity and remarks on the history, personnel, and outlook of the various programs in these German installations.

C-9-76 THE INTERNATIONAL CONFERENCE ON COLLOID AND SURFACE SCIENCE (IUPAC), BUDAPEST, HUNGARY, 15-20 SEPTEMBER 1975, by A.L. Powell, ONR, BOSTON

This report covers contributions made at an IUPAC-sponsored conference on colloid and surface science convened in Budapest, Hungary, during the period of 15-20 September 1975. Papers at the meeting covered a wide range of theoretical and experimental approaches to research in colloid and surface science. A number of plenary and main lectures were offered, most of which were of a review nature and set the tone for the conference. The meeting also provided a forum for scientists from the East and West to meet informally and exchange research information.

C-11-76 COLLOQUIUM ON SOLID-STATE TRANSMITTERS FOR RADAR, by CDR D.A. Hart

The Institution of Electrical Engineers' Colloquium on Solid-State Transmitters for Radar was held in London on 9 January 1976. The 10 papers presented discussed various components and devices such as GaAs transferred electron oscillator, IMPATT and TRAPATT device for generating microwave power for radar applications. Also discussed were radar systems employing solid-state devices, e.g., radar altimeters, Doppler radars and battlefield surveillance radars. A brief discussion of each paper is presented.

C-12-76 "FIFTH INTERNATIONAL SYMPOSIUM ON BORON AND BORIDES, by Forrest L. Carter (NRL, Washington, DC) and Charles Feldman (APL, Johns Hopkins Univ., Laurel, MD)

The Fifth International Symposium on Boron and Borides was held at the University of Bordeaux, Talence, France, on 8-11 September 1975. The conference emphasized the relation of crystal structure and chemical bonding to properties and applications but other major topics included reaction kinetics in the preparation of amorphous boron, vibration and optical spectra, band structure, and magnetic and semiconducting properties. In the area of applications the main topics included the surface treatment of steel for wear resistance, the hardness of boron and borides, and the protection of boron fibers in metallic composite materials.

C-13-76 IMAGING IN MEDICINE: THE SEVENTH L.H. GRAY CONFERENCE, LEEDS, 1976 by J.H. Schulman

This topical conference provided an excellent introduction to fundamental aspects of medical image formation and interpretation as well as an account of the current state of the art and a forecast of future techniques. Methods of image formation considered were: x-rays (ionography and computerized tomography), radionuclides, ultrasonics (macro-imaging and acoustic microscopy), thermography, and nuclear magnetic resonance. Special emphasis was given to the problems of image perception, image processing and extraction of numerical information from images. This Report discusses some highlights of the Conference and gives the full Conference program as an appendix.

C-14-76 ENERGY AND PHYSICS -- THIRD GENERAL CONFERENCE OF THE EUROPEAN PHYSICAL SOCIETY by Roy F. Potter

The Third General Conference of the European Physical Society, held in Bucharest, Romania on 9-12 Sept 1975, and entitled "Energy and Physics", was organized into plenary sessions as well as several parallel sessions. Most plenary sessions were devoted to applied and fundamental aspects of modern energy technologies. These and other topics such as astrophysics, many-body problems, elementary particles, were developed further by invited speakers at the parallel sessions. This report covers portions of most of the plenary sessions including the opening session of the Conference, Physics and Energy (Kapitza), Energy Strategies (Häfele), Maturity of Nuclear Energy (Weinberg), Use of Solar Energy (Aigrain), Energy Today; New Goals and Challenges (Ursu), Photochemistry (Archer), Thermonuclear Research (Braams), Energy, Dissipation and Structure (Nicolis), Transport and Storage of Energy (Marchetti). Other sessions covered are on solar energy use, transport and storage of energy and energy research strategies.

C-10-76

THE FIFTH INTERNATIONAL BIOPHYSICS CONGRESS: FOUR VIEWS
by M. Blank, J.W. Twidell, R.J. Werrlein, J.B. Bateman

A report by four participants dealing with different aspects of the conference including: Emphasis on Membranes; Active Transport; Electrophysiology of Nerve Membranes; Interaction of Light with Cells; Cell Shape; Wider Applications of Biophysics; Membrane Bound Enzyme Systems; Education in Biophysics; Gating Currents; Membrane Noise Analysis; the Nature of Biophysics; the Future of Large International Meetings; Biophysical Aspects of Global Problems such as Changes in the Upper Atmosphere; Emission of Radioactive Gases by Reactors, Mechanisms of Chemical Carcinogenesis.